

Emerging digital technologies in the public sector

The case of virtual worlds

Independent
Expert
Report



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Manuscript completed in June 2024
First edition

PDF	ISBN 978-92-68-18897-2	doi:10.2777/398037	KI-02-24-748-EN-N
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Luxembourg: Publications Office of the European Union, 2024

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FOREWORD

Disruptive technologies often challenge the limits of existing regulatory frameworks. The emergence of generative AI, for example, gave rise to deepfakes and forced us to re-assess our conception of truth and disinformation. The potential effect of this development on aspects varying from individual fraud to the integrity of our elections is an obvious one. As technological progress accelerates, it is imperative to have anticipatory instruments in place that can assess the potential regulatory impacts of disruptive innovation and make recommendations to ensure its alignment with EU values and principles. The report you are currently reading is the result of one such instrument.

The Innovation Friendly Regulations Advisory Group (IFRAG) was appointed for a 1-year renewable mandate until February 2024. Its purpose is to provide upstream advice and improve the general understanding of the relation between innovation policy and regulatory policy, thus contributing to the overall resilience of the EU's regulatory framework. The group of 13 experts examined the use of virtual world technologies in the public sector.

Their deliberations spanned across multiple areas of expertise, encompassing legal, social sciences, investment, and technological angles.

The report provides insights into the future development of virtual world technologies, their benefits, as well as their risks, and makes a range of recommendations on how the EU and its Member States can shape the role and use of this innovative technology to support the digitalisation of the public sector and public services in the EU. It can serve as a foundation and inspiration for future actions in the field of virtual worlds.



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ABSTRACT

This report examines the policy and regulatory implications of using virtual world technologies in the public sector. It includes an outline of the potential socio-economic benefits of virtual worlds for the public sector, citizens and businesses. Drawing on three different scenarios for the possible development of virtual worlds in the next 10 to 15 years, the report uncovers some social, economic, technical and regulatory challenges related to the deployment of virtual worlds. The primary objective is to look at the EU's existing regulatory framework and assess it in relation to ongoing and foreseeable developments in virtual world environments. We conclude that, because many virtual-world-enabling technologies are already the subject of regulations such as the Digital Markets Act, the Digital Services Act, the recent Interoperable Europe Act and the AI Act, existing EU legislation is probably enough to align virtual worlds with EU values in the short and medium term. However, as virtual worlds technologies mature, targeted amendments to legislation will likely be necessary. Moreover, the cross-cutting nature of these technologies requires intervention in addition to regulation and calls for a broader socio-technical approach that addresses issues related to people, industry, governance and infrastructure. This report provides recommendations related to those dimensions, as well as areas of future research.

Keywords: virtual worlds, VR, digital technologies, public sector and innovation.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the organisational support of different services of the European Commission; and particularly the co-leaders of the Secretariat: Directorate-General for Research & Innovation (DG RTD) – especially the Common Programme Analysis & Regulatory Reform Unit (RTD.G2) – and the Joint Research Centre's Digital Economy Unit (JRC.T1). Furthermore, the authors would like to thank the Commission's Directorate-General for Communications Networks, Content and Technology (DG CNECT) and Directorate-General for Informatics (DG DIGIT) for thematic and coordination support. Two experts (Eline Chivot and Marc Perez Battle) left the group due to professional reasons before the end of their mandate. The authors would like to thank them for their valuable input into the report while they were members of the IFRAG.

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DISCLAIMER

Nothing in this document shall be construed or interpreted as providing legal advice or guidance concerning how compliance with any applicable existing legal norms and requirements can be achieved. Nothing in this document shall create legal rights or impose legal obligations towards third parties. We nevertheless remind readers that it is the duty of every natural or legal person to comply with laws – whether those applicable today or those that might be adopted in the future – that are relevant to virtual worlds. Our recommendations are based on the assumption that all legal rights and obligations that apply to the processes and activities involved in developing, deploying and using virtual worlds will remain mandatory and must be duly observed.

EXECUTIVE SUMMARY

Policy context

On 5 July 2022, the Commission's Communication on a New European Innovation Agenda¹ tasked the IFrag with focusing on the use of emerging technologies in support of the public sector to improve, optimise and innovate its operations and service provision. The IFrag was also asked to concentrate on concrete applications (i.e. use cases) of emerging technologies in fields that are likely to be relevant to the public sector. Virtual worlds were identified as the emerging technology from which to extract use cases.

On 11 July 2023, the Commission adopted its Communication on an EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition. In parallel, several relevant legal acts have entered into force or are about to do so: the Digital Markets Act, the Digital Services Act, the Interoperable Europe Act and the Artificial Intelligence Act. These complement an already rich regulatory framework. However, emerging digital technologies like virtual worlds tend to challenge the status quo (including existing policies and legislation) and require special attention in order to ensure that rules remain flexible enough to adapt to changing circumstances and to safeguard intended policy objectives. The IFrag was specifically tasked with contributing to this conversation with anticipatory thinking on the link between innovation (virtual worlds in this case) and the EU's regulatory framework.

Key conclusions

- Virtual worlds can improve the quality of life for EU citizens and increase the competitiveness of EU industry. They can also enrich the way public services are provided. Areas such as education, healthcare and emergency services are already benefiting from their use.
- This potential nevertheless brings risks. The main developers of virtual worlds infrastructure and applications are located in the US and Asia. This raises two overarching problems. First, virtual ecosystem rules could be in conflict with EU values and legislation. Second, the existing dynamics could lead to economic value transferring out of the EU.
- Existing technologies such as artificial intelligence (AI) and blockchain are enabling virtual worlds. This complementarity means that known issues linked to enabling technologies, interoperability, legislation and innovation are transferable to the realm of virtual worlds.
- It is difficult to predict how virtual worlds will develop in the next 10 to 15 years, so the IFrag considered three possible governance scenarios for the technology's further evolution:
 - Scenario 1: virtual worlds could develop as predominantly **community-owned** entities or networks;
 - Scenario 2: virtual worlds could develop as predominantly **corporate-owned** entities and networks;
 - Scenario 3: virtual worlds could develop as a **combination** of the first two scenarios above – with some of the key infrastructure and/or applications

¹ For a complete list of the EU policies and legislation referred to in this report, see Annex 1.

of virtual worlds being community-owned and the rest being corporate-owned.

- Public services can be deployed through virtual worlds in very different ways, depending on the actual development and governance of the technology and the resulting ecosystem but especially depending on the areas of application and modes of use by the target audience.
- Many examples of virtual worlds already exist, but the authors of this report foresee a new wave of virtual world instances aimed at solving sector-specific challenges (e.g. in healthcare, education and other relevant sectors). Urban services (such as the CitiVERSE) and mobility are citizen-oriented services where the public sector might play a particularly strong role.
- Existing legislation (e.g. the AI Act, the Digital Services Act and the Digital Markets Act) will probably be sufficient to address issues raised by virtual worlds in the short and medium term. However, as the technology matures in the longer term, virtual-world-specific amendments will have to be introduced to cover elements typical of virtual environments (e.g. biometrics and informed consent).

Recommendations and next steps

Virtual worlds offer many untapped opportunities for enhancing the development and delivery of better services, but it is crucial to exercise caution when applying virtual worlds models in the public sector. Three questions should be addressed before applying virtual worlds environments to public administration:

1. Where would the application of the virtual worlds model be most useful?
2. What are the most important sectors that would benefit from it?
3. Which users would ultimately benefit the most from such digital transformation?

Equally importantly, there are some **fundamental requirements** to consider when introducing innovative technology into public administration:

- innovative technology, services and models need to be **relevant** (to actual needs);
- **useful** (usefulness is about defining the real value of virtual worlds – providing more value to users than the existing alternatives (e.g. in the health sector));
- **necessary** (no other valid alternatives should exist – e.g. the natural environment);
- **wanted** (the technology should never be imposed on final users against their will);
- **accepted** (the technology should be accepted by users among equally valid alternatives);
- **suited to / preferred by** the target contexts/users (not disruptive of underpinning values and needs (e.g. education – cognitive development));
- **attractive** (e.g. appealing and user-friendly – not dystopian);
- nourishing and **enriching/empowering** (not as an escape from reality);
- **accountable** and assessable (governance should be aligned with the public interest);
- **respectful** of the public sector mandate, and its underpinning principles and social values (institutions should monitor responsibilities and impacts).

To meet these fundamental requirements, proposed virtual worlds models must demonstrate tangible benefits for users (be they public administrations, citizens or businesses) when compared with existing solutions. This report therefore focuses on four dimensions: people, industry, infrastructure and governance. As shown in the table, the use

of virtual worlds in the public sector could raise specific challenges for each dimension. This report therefore makes a series of recommendations for the EU and its Member States (MS), in order to pave the way for the use of virtual worlds in the public sector in line with EU values and policy objectives.

Dimension	Challenges	Recommendations for the EU and MS
People	<ul style="list-style-type: none"> • socio-technical complexity • ensuring respect for digital rights and principles • participatory innovation: how to make virtual worlds inclusive? 	<ul style="list-style-type: none"> • take a leadership role in the development and use of virtual worlds • provide capacity-building and skills development • foster crowdsourcing and open innovation • empower citizens through proactive information provision, education and awareness-raising
Industry	<ul style="list-style-type: none"> • competition issues • lock-in risks 	<ul style="list-style-type: none"> • encourage open standards on interoperability • facilitate transparency and accessibility of purchasing • take a leadership role in the development and use of underlying enabling factors and features
Infrastructure	<ul style="list-style-type: none"> • cost of deploying a virtual world, financial viability over time • environmental sustainability 	<ul style="list-style-type: none"> • increase public funding of virtual worlds • enable pre-commercial procurement (PCP)
Governance	<ul style="list-style-type: none"> • risk mitigation • governance and community engagement • content moderation • open and decentralised virtual worlds • advertising rules on intellectual property 	<ul style="list-style-type: none"> • provide an agile regulatory framework (including through regulatory sandboxes) • share best practices and collaborative learning in procurement

1. Introduction

As set out in the Commission Communication on a New European Innovation Agenda, a new wave of innovation is on its way. Deep tech innovation – rooted in cutting-edge science, technology and engineering – can deliver transformative solutions to pressing societal challenges. In turn, regulatory frameworks are under pressure to keep pace with rapid technological development, while ensuring that policy objectives, rights and values are duly respected and safeguarded. Understanding – in a timely manner – how emerging innovations interact with specific policies and legislation remains a challenge for policymakers.

The Commission has therefore set up a new expert group, the Innovation Friendly Regulations Advisory Group (IFRAG) to provide upstream advice and improve the general understanding of the relationship between innovation policy and regulatory policy, thus contributing to the overall resilience and relevance of the EU's regulatory framework. In particular, the IFRAG's mandate is to identify and evaluate the expected impact of innovative technologies and to provide recommendations on regulatory design of policies in order to potentially support the diffusion and use of these innovative technologies, while ensuring that they can be deployed safely and sustainably.

In light of the above, the IFRAG focused on **the use of emerging technologies in support of the public sector** to improve, optimise and innovate its operations and service provision. To do so, the IFRAG analysed concrete applications (i.e. use cases) of emerging technologies in fields where the public sector is likely to be present. **Virtual worlds** were identified as the emerging technology from which to extract use cases.

Beyond evaluating the characteristics of virtual worlds, the IFRAG's mandate was to envision the future of this immersive technology and to reflect on regulatory challenges that virtual worlds will pose, particularly in the public sector. This report therefore focuses on the development of virtual worlds, by elaborating and evaluating potential governance scenarios and their implications for public services provisions in different sectors, in order to identify potential consequences for EU digital policy and regulation.

The IFRAG was active for 1 year, from March 2023 to February 2024. The authors of this report met for four full-day meetings and interacted throughout the year to form their views around the role, challenges and possible uses of virtual worlds in the public sector. Their findings and recommendations are set out below.

1.1 Definition of virtual worlds

The Commission Communication of July 2023 on an EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition defines virtual worlds as '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, simulating, collaborating, learning, socialising, carrying out transactions or providing entertainment'. The concepts of virtual worlds and metaverses are used interchangeably throughout this report.

This definition will be used as a basis for the content that follows. The authors of this report see opportunities to further refine the definition, particularly to include different types of virtual words that already exist. They therefore propose in Annex 2 a revised definition to

enhance both the specificity and comprehensiveness of the working definition, and to systematise the characteristics of virtual worlds.

1.2 Target audience and structure

This report synthesises the work of the IFrag and presents its final recommendations. It is primarily addressed to policymakers and practitioners in EU public administrations, from local to EU level.

The rest of this report is structured as follows.

- Section 2 explores three possible governance scenarios for virtual worlds in the short and medium terms. It also touches on their likelihood and desirability.
- Section 3 turns to the specific focus of the IFrag (i.e. the public sector) and examines possible applications of virtual worlds by public authorities in the EU. It also examines specific enablers that are crucial for a use of virtual worlds in the public sector that would meet the expectations of potential users in terms of quality and experience, while being in line with EU core principles and values.
- Section 4 considers the EU legal framework and its link with virtual worlds in the public sector, under the three scenarios introduced in Section 2.
- Section 5 provides a deep dive into a specialised instance of virtual worlds – the EU CitiVERSE – in order to illustrate in operational terms what has been presented in the previous sections.
- Section 6 turns to emerging policy and regulatory issues that policymakers should consider in the coming years in light of the opportunities and challenges identified by the IFrag.
- Section 7 concludes with the authors' key messages and recommendations and with possible next steps.

2 Envisioning the future of virtual worlds

It is difficult to predict how virtual worlds will develop in the next 10 to 15 years, so this report has considered three possible governance scenarios for the technology's further evolution. These will frame the analysis, discussions and recommendations in this report:

- **Scenario 1: virtual worlds as predominantly community-owned entities or networks:** where virtual worlds' key infrastructure and applications are open to everyone and are administered collectively by the people using them;
- **Scenario 2: virtual worlds as predominantly corporate-owned entities or networks:** where virtual worlds' key infrastructure and applications are proprietary solutions administered by the corporations owning them;
- **Scenario 3: virtual worlds as a combination of the above:** where some of the key infrastructure and/or applications of virtual worlds are community-owned, while the remaining ones are corporate-owned.

Each of these scenarios implies different (positive or negative) impacts on society and raises various issues regarding governance and regulation. This report examines the specific challenges of each scenario in more detail below, indicating possible implications for public sector organisations.

2.1 Critical examination of the three scenarios

2.1.1 Examination of community-owned virtual worlds (Scenario 1)

Governance: Scenario 1 could create challenges for public administrations and governments, particularly **if the platform lacks clear governance structures or regulatory frameworks**. Governance can be defined as ‘the multitude of actors and processes that lead to collective binding decisions’ (Van Asselt & Renn, 2011: 431). Governance therefore refers to the multiple actors who, with varied responsibilities, assume accountability and oversight for virtual worlds. The goal would be to ensure a multi-stakeholder representation and participation to enhance overall legitimacy and related governance. For example, public administrations may need to work with citizen groups and other stakeholders to develop appropriate policies and regulations for virtual worlds, and to ensure that whichever platform is used is accessible by and inclusive for all citizens.

User experience: in Web 2.0, the convenience of user experiences provided by open community solutions has somewhat lagged behind that offered by corporate solutions. Community-administered virtual worlds may therefore not optimally correspond to the way that the EU seeks to promote the accessibility of digital services.

Fragmentation: a further risk is that the **landscape of virtual worlds could become overly fragmented**. Even if common standards and open interfaces for solution integration exist, that does not mean that they will be used to integrate the solutions in question (e.g. across all aspects of users’ virtual daily lives). Scenario 1 could thus result in many disconnected communities and/or solutions lacking the ability or incentive to generate critical mass and leverage positive platform effects.

2.1.2 Examination of corporate-owned virtual worlds (Scenario 2)

Power imbalance: as noted elsewhere (Madiaga et al., EPRS, 2022), the development and scaling-up of virtual world activities is likely to concentrate the power of the global technology giants commonly referred to as Big Tech (e.g. Alphabet, Amazon, Meta and Microsoft) even further. Indeed, we need to consider what is needed for virtual worlds to be developed: for example, integration of different building blocks (devices and platforms) and sufficient computational power to allow large numbers of users to use this virtual world. Small enterprises can develop applications but may rely on deals with Big Tech companies that give them access to their vast data and computing resources. Defining and implementing EU standards for virtual world platforms to foster interoperability is becoming a crucial step, especially if Big Tech players continue to dominate investment and development in this area.

Public-private partnership: Scenario 2 could create risks for public administrations and the provision of public services, particularly if virtual worlds become an important channel for the delivery of public services, such as education, healthcare, and social welfare. For instance, a privately-owned virtual world could lead to a quality gap between the experience it provides and the service offered by a public sector virtual world. This gap could in turn create pressure on governments to ‘catch up’. If they fail to provide services that offer an online experience which citizens will judge favourably, trust in their own legitimacy to do so could be damaged. **Public administrations may need to work closely with the private sector** to ensure that citizens’ needs are met and that public values are upheld in virtual worlds. That also requires industry’s buy-in and willingness to collaborate, which could be a problem if it is in industry’s interest to pursue dominance.

Competition and interoperability: Scenario 2 could lead to an oligopolistic market structure where a relative lack of competition results in worse outcomes for users. It might also create a ‘lock-in’ situation, when users become so dependent on a particular software

vendor's product or ecosystem that switching to any alternative becomes too challenging and costly. **Interoperability plays a crucial role in reducing lock-in situations** by enabling compatibility and seamless integration between different software systems and platforms.

Data governance: in Scenario 2, public administrations will deal with private companies that tend to prefer to have proprietary rights over users' data. This leads to several challenges. For instance, **data responsibility: who will be responsible for storing, handling and safeguarding personal and/or added-value data?** Moreover, generated added-value data should be a common good. This is a well-known problem, fortunately, but it also remains difficult to solve. The solution lies in the development of clear standard guidelines and clauses that establish the contractual relationship between the public administration and the private company. These clauses must also cover potential inspections or audits of the solution as well as specific sanctions that may be activated if the contract is somehow not respected.

Accountability and explainability: public services' decisions and actions must be explainable. When decisions are made or actions are taken, **public officials must be able to explain the rationale behind their choices** and demonstrate that they are acting in the best interest of the public. Explainability holds public servants accountable for their decisions and helps prevent arbitrary or unjust practices. For instance, AI can make it difficult to explain public service due to its complex and often opaque decision-making process (e.g. black box algorithms or data-biased algorithms). Metaverse-based public services may include this kind of algorithm and thus jeopardise the effective accountability and explainability of the public service decisions that have been taken.

2.1.3 Examination of the combined ownership of virtual worlds (Scenario 3)

Scenario 3 is a hybrid of Scenarios 1 and 2 and therefore involves a combination of the challenges described above. The prominence of these challenges depends on the balance in Scenario 3 between Scenario 1's community-owned dimension and Scenario 2's corporate-owned dimension. As mentioned, all combinations are possible and it is difficult at this stage to predict which one would prevail. The exact balance is also likely to vary according to sector.

Regardless of the combination, two types of archetypical actors can easily be identified and characterised (Andriole in Forbes, 2022). Their respective roles should be considered in order to draw the relevant policy and regulatory conclusions for public sector applications. The two archetypical actors are as follows.

- The **infrastructure organisation** is able to mobilise significant resources and expertise for the development of critical virtual worlds infrastructure. Driving the infrastructure, these organisations would play a critical role in defining technical standards and governance. This role could in principle be assumed by organisations from any sector, but current examples are almost exclusively large private-sector entities (e.g. Microsoft, Google, Nvidia, Apple, Meta and Unity). These companies are working to produce virtual worlds devices (e.g. headsets) and/or the chips that power them, as well as accompanying 3D hardware and software for rendering, interactivity, connectivity and cybersecurity.
- The **applications developer** builds apps for and on virtual worlds infrastructure. Depending on the application, this could also require the resources and expertise of a global technology incumbent as mentioned above, but small-scale start-ups, open-source communities, individual developers and governments may also provide these solutions. These applications would use the enabling infrastructure provided by other

organisations, so their developers would have only limited ability to influence aspects such as interoperability.

Equilibrium: the main challenge of this scenario is therefore to achieve an adequate equilibrium for the public/private ownership of virtual worlds that ensures an effective and efficient provision of public services without threatening individual rights or concentrating the power of global technology players. It is also crucial to consider how ownership is divided along the infrastructure/applications line between public and private actors.

2.2 Likelihood and desirability of the scenarios

2.2.1 Likelihood of the scenarios

In terms of the likelihood of each scenario occurring, all three could exist at different points in the evolution and different levels of maturity of virtual worlds.

The current situation appears closest to Scenario 2 and it is likely that short-term to medium-term development will continue along these lines. Examples of virtual worlds already in existence include Second Life, Roblox, Fortnite, Minecraft servers and World of Warcraft. These are all private applications and run on infrastructure that is predominantly privately-owned and governed (e.g. servers and virtual reality headsets), while only some of the basic infrastructure is publicly owned and governed (e.g. deep-sea internet cables, domain name systems and transmission control protocol / internet protocol).

The initial development of internet infrastructure was driven by government-funded research in the public interest, but leading companies in the tech and gaming industries have recently overtaken public research and investment in digital technologies. Private companies may therefore provide an increasing amount of key infrastructure and applications for virtual worlds, thus keeping the state of play even more firmly within Scenario 2. However, as virtual worlds become more widely adopted and integrated into various aspects of society, there is likely to be increasing demand for interoperability and standardisation across different virtual worlds. This could potentially drive the development of more open and community-owned virtual worlds (Scenario 1). Scenario 1 nevertheless appears less likely at present, especially without significant government intervention (e.g. regulation or financial support schemes).

Overall, it is highly likely that private companies will remain in the driving seat as primary developers of virtual worlds with a potential lack of interoperability and transparency. However, virtual worlds will also become spaces for public activity and, potentially, venues where people (e.g. politicians and artists) or businesses will have to be present. This requires thorough reflection on the role that private and public sector actors can play in the governance of virtual worlds.

Therefore, while Scenario 2 is expected to remain predominant in the short term and even the medium term, the role of community-owned and governed services could grow under the right circumstances and steering. Depending on those developments, a more balanced approach of Scenario 3 could potentially be achieved in the longer term.

2.2.2 Desirability of the scenarios

The most desirable scenario will ultimately depend on a range of factors. These include the goals and priorities of different stakeholders; the specific features and capabilities of the metaverse; the broader societal and economic context in which the metaverse operates.

Some of these factors are beyond the scope of this report, so a conclusive evaluation of scenario desirability cannot be provided here. This report does nevertheless contain an

initial evaluation of scenario desirability based on current regulatory, technological, economic and societal factors.

Scenario 1 (where virtual worlds' key infrastructure and applications are predominantly community-owned, open and administered collectively by the people using them) could result in virtual world experiences that are inclusive and fair in terms of user choice; provide greater opportunities for democratic user participation; and can most easily be integrated into public service delivery. This would most probably result from open developer communities leveraging open standards and democratic governance modes; and possibly governmental financial support and even distributed ledger technology (DLT) to create a range of diverse yet integrated solutions.

However, although innovation and development may benefit from open standards, a lack of market incentives and the significant coordinative efforts associated with consensus-driven distributed technology development and operation may ultimately cause the pace of innovation and development to be somewhat slower than in Scenario 2. In addition, community-owned virtual worlds may struggle to become financially self-sufficient (particularly if they are initially created by governmental funding) and this may potentially require users to frequently move their assets or daily routines to another virtual world. User experiences would probably be more inclusive and fairer (due to a relative lack of market incentives) but may be somewhat less convenient than in Scenario 2.

Scenario 2 (where virtual worlds' key infrastructures or applications are predominantly proprietary solutions administered by the corporations owning them) could result in more rapid innovation and development of the metaverse, and possibly in the most convenient (although not inclusive or fair) user experiences. This scenario would most probably result from the currently dominant tech companies competing to create the most advanced and compelling virtual environments as 'walled gardens'.

In this scenario, however, corporations would – as providers of the key virtual worlds infrastructure and applications – probably define central technical standards and protocols, and shape them to suit their own business models and interests. They would therefore probably provide only a limited degree of openness to third parties or control to users, potentially limiting user choice and undermining the democratic governance of virtual worlds.

Scenario 3 (where virtual worlds are a combination of the first two scenarios) could offer the best of both worlds, with companies contributing proprietary solutions to a larger and more open ecosystem that promotes cross-solution and cross-sector interoperability and collaboration. This scenario is therefore the most desirable for stakeholders involved in the use of virtual worlds for the provision of relevant public services.

A general mix of proprietary and community-owned solutions arguably already exists and may continue to exist. However, an even distribution of ownership and control over key infrastructure and applications would be difficult to achieve in practice, because the two types of actors require different (and possibly mutually exclusive) economic and societal conditions to prosper. Therefore, instead of achieving a fully even distribution, it is more realistic in the context of Scenario 3 to expect an 'equilibrium' in the distribution of ownership and control per sector. This is at least an approach to potentially aim for.

In addition, the concrete desirability and anticipated impacts of Scenario 3 greatly depend on the specific way in which governance and ownership are distributed across different parts of the virtual world technology stack and services provided. For example, a version of Scenario 3 in which corporations own and administer the key **infrastructure** of virtual worlds while open communities own and control the key **applications** of virtual worlds would probably give corporations greater control and influence than the open communities. The opposite would probably be true if the situation were to be reversed.

In conclusion, several variations of Scenario 3 are possible and desirable. Their exact features are likely to evolve in the coming years and their set-up might vary depending on many factors, which are not yet fully known. However, the potential roles of public sector organisations and need for possible policy measures can already be explored in order to develop recommendations for dedicated actions.

3 Virtual worlds and their relationship with the public sector

Depending on where and how these environments evolve, the safe adoption of virtual worlds, technologies and tools will require the **consultation and participation of a rich ecosystem of stakeholders at the evaluation and shaping stages**. These stakeholders might include policymakers at different levels of administration; city planners; engineers; schools and teachers; enterprises; and consumer and industry associations.

The EU can proactively influence the development of virtual worlds, including through dedicated multi-stakeholder activities, such as targeted public spending (e.g. procurement, grants and incentives) as well as targeted facilitation initiatives (e.g. dialogues, dedicated communities, accelerators, publications and events). This is particularly relevant when it comes to the development of virtual worlds aspects pertaining to the provision of public services. Such targeted interventions should therefore be taken into consideration and proactively steered in tandem with further legislation enhancements. These efforts could ultimately foster the development of specific innovation, of a relevant GovTech market in the EU and of public interest technology applying technology expertise to generate public benefits and to promote the public good.

The next section examines the possible applications of virtual worlds in the public sector and highlights critical enablers.

3.1 The unique role of the public sector

The public sector comprises both public services and public enterprises. It includes various public goods and governmental services (e.g. public administration, defence, law enforcement, infrastructure, public transport and education), healthcare and those working for government bodies, such as civil servants. Furthermore, the public sector is driven by the rule of law (e.g. scrutiny and accountability, applying equality, transparency and consistency in decisions and offering redress whenever needed). Its **primary objective is public value creation**. It aims at achieving the public good for diverse communities and its mandate is to protect citizens and promote overall well-being.

The values underpinning the actions of the public sector are in the EU context derived from Article 2 of the Treaty on the European Union: 'The EU is founded on the values of respect for human dignity, freedom, democracy, equality, the rule of law and respect for human rights, including the rights of persons belonging to minorities.' This is reflected in the EU's governance system, which designates the body of rules, procedures and practices covering how powers are exercised. The objective is to strengthen democracy at all levels of public administration, increasing the trust of citizens in public institutions, agencies and bodies.

The **legal and administrative nature of the public sector also makes it radically different from the private sector when it comes to technology adoption and use**. For example, a difference can be seen in customer acquisition focus. Private-sector organisations target the most profitable customer groups, but public-sector organisations

are required to provide public services in the digital sphere for all – including vulnerable and disenfranchised groups, who make up more than a third of the EU's population (more than 150 million citizens). The public sector's use of technology also concerns the most critical segments of society, and regulation is crucial to tackling the needs and vulnerabilities of those groups.

In this context, it is important to highlight that public sector administrations operate within highly diversified and complex political, cultural and socio-economic ecosystems. Public administrations differ from private-sector organisations due to a number of fundamental characteristics that underpin their values and determine their objectives, instruments, roles and relationships with other actors. It is therefore likely that the application, use and purpose of virtual worlds technology in the public sector cannot simply copy the examples of private or commercial enterprises.

More importantly, **public administrations do not just provide services, but also regulate the activity of citizens and the use of public power and coercive force** (e.g. taxation, licensing, law enforcement and detention). It is in the exercise of such functions that directly affect people's legal status, rights and interests, that administrative decision-making principles raise particular issues that are unique to the public sector. The exercise of such powers requires the public sector to comply with administrative law and ethical and human rights principles (Leslie et al., 2021); and promotes a whole-of-government approach (EESC, 2016).

Administrative law has developed over many centuries and is essentially principles-based. It is nevertheless interlinked with the evolution of key socio-economic phenomena, such as the industrial and technological revolutions. Technological change does not impact fundamental administrative law principles, but new technologies affect the application of such principles in practice. Any use of technology by government must therefore be considered from an administrative law perspective, including matters related to ethics and human rights.

For these reasons, while technology does bring benefits and opportunities, it also comes with a potentially high impact and risks. When it comes to applications in the public sector, virtual worlds models and their implications need to be taken into consideration very carefully. A focus must be put on:

- i) clear added value for the users, whether they are public administrations, citizens or businesses;
- ii) proportionality between benefits and risks; and between ethical, legal and human rights considerations.

3.2 Possible applications of virtual worlds in the public sector

Virtual worlds provide both opportunities and challenges for the public sector when it comes to striking the right balance between the potential for opening new digital channels to offer public services and the responsibility to safeguard citizens against potential threats. Innovation-friendly regulation can help in achieving both.

This report identifies several types of public services that may be impacted by virtual worlds, and cases where virtual worlds may open new opportunities for more effective delivery. Sectoral-specific considerations are further examined below.

Virtual worlds offer significant potential for innovative applications in the **healthcare sector**, including surgical training and simulations; rehabilitation through virtual reality; medical education and training; mental health therapy; and even health and wellness promotion. **The use of virtual worlds in healthcare applications is expected to be one of the first to develop, given the high-paced development of the med-tech field and its various applications**, including telemedicine consultations; remote diagnostics solutions; and remote medical monitoring (with and without the use of medical wearables). Innovative med-tech solutions are often heavily funded, which helps accelerate development. We have identified **two types of users** for this kind of application: (i) general users/citizens; and (ii) healthcare workers. The latter will be present in most of the envisioned virtual world applications, ranging from training purposes to scenario simulations and interaction with general users. Virtual worlds and immersive technologies can be seen as a transition to a new paradigm. They can redefine user experiences, foster innovation and create innovative ways of interaction. They provide a platform where healthcare services can transcend the boundaries of conventional approaches, thus allowing more personalised, efficient and engaged interactions, such as using virtual worlds as a digital therapy to treat pain in children. General users, however, are likely to be involved in some applications, particularly those linked to the actual provision of medical services. **The required levels of interoperability and security of virtual worlds will vary depending on whether or not general users are present.** If they are not present, it is possible to consider virtual worlds as an internal application of the healthcare service provider. Conversely, the use of virtual worlds by patients of the healthcare sector raises the core question of how to protect a highly sensitive category of personal data.



For this application, we expect **Scenario 2** to be more prominent in the immediate future, although a mixed private-public combination (**Scenario 3**) is possible with targeted public funding and action.

Virtual worlds have significant potential to be used and to foster innovation in **education**. **Education primarily targets a young population** that tends to be more open to accepting innovative digital technologies and applications, so **the use of virtual worlds in the education sphere could be one of the first use cases within the public sector**. Innovation brought in by virtual worlds can ensure access to quality education for all, with a focus on students. It can help level the educational playing field by offering virtual classrooms and educational resources to individuals, irrespective of race, gender, disability and medical or other need. It can provide tailored learning experiences, adaptive content and opportunities for skill development. Immersive technologies can offer a variety of sensory experiences and interactive learning opportunities that cater to different learning styles, thus fostering a more inclusive, immersive and engaging learning experience. School leaders and educators can improve their competencies through professional development that is enabled within virtual worlds. However, recent studies of remote learning practices used during the COVID-19



pandemic have highlighted some challenges. These studies indicate a possible decrease in cognitive abilities; shallow learning and retention; extreme isolation phenomena; and a loss of perception of reality, including time and physical experiences. This discrepancy is attributed to the absence of fundamental pillars of teaching and learning (i.e. physical and emotional experiences). Furthermore, both educators and staff currently lack the level of digital literacy they need to be able to navigate digital and virtual worlds effectively. The use of virtual worlds in education should not be seen as an alternative to physical learning but rather as a complement to existing teaching and learning methods.

In education, we expect **Scenarios 2 and 3** to be more prominent in the immediate future.

Public services in **culture and recreation** include libraries, museums, parks and sports facilities. These all contribute to the enrichment of cultural and recreational life. Virtual worlds can significantly foster culture through innovation in several ways. Public art and cultural programmes can thrive in virtual worlds, fostering creativity, expression and cultural appreciation. Virtual cultural experiences supported by immersive technologies are a fashionable option. They allow people to explore and engage with historical sites or museums from anywhere in the world. Other approaches are also gaining ground (e.g. augmented reality (AR) to better interact with and understand a historical site). People can create and



participate in online communities that are based on shared interests, hobbies and recreational activities and have real virtual interactions which might be hosted by local authorities.

We expect **Scenarios 2 and 3** to be more prominent in the immediate future in culture and recreation.

Innovating **social services** through virtual worlds has the potential to increase the quality of service for citizens by improving accessibility; extending the reach of support programmes; and crafting individualised and captivating experiences for both individuals and communities that need help. This is an exceptional opportunity to tackle social issues and improve the welfare of marginalised populations. Accessibility features can be incorporated into the design of virtual worlds in order to ensure the full participation of individuals with disabilities. Such features include sign language interpretation, screen readers and adaptable avatars, which are all designed to cater to diverse needs. In addition, virtual hubs can function within virtual worlds as all-encompassing repositories of social services and community resources. Users could effortlessly retrieve information on food aid, housing assistance, healthcare services and a variety of other resources. Social service providers can develop immersive simulations in order to provide instruction on crucial life skills, such as financial literacy, preparation for job interviews and conflict resolution. These interactive encounters are a way for individuals to acquire hands-on practical skills that foster self-sufficiency. Social services can engage young people through gamified experiences and interactive platforms in virtual worlds. This can promote youth empowerment, mental health awareness and skill-building. In addition, social worker skills can also be improved through virtual worlds in a similar way to health and education. Critical but rare situations can be simulated in virtual worlds in order to test social workers' reactions without any negative impact on the users. It is crucial to explore the potential of virtual worlds in social service provision, especially given the findings from previous studies that highlight the need for both a digital and a human presence in delicate situations. This dual approach recognises the value of combining the digital realm with human interaction to bridge gaps in support.



For this application, we expect **Scenarios 2 and 3** to be more prominent in the immediate future.

Public administration, especially **local public administration**, may be greatly impacted by innovation through virtual worlds. One example of public initiatives aimed at virtual and worldwide service provision is the virtual residency established in Estonia. Individuals outside Estonia can apply for e-residency in order to gain most of the benefits of Estonian citizenship, including the ability to incorporate a business in the country (but not the right to vote in Estonian elections). The growing number of e-residents introduces a unique dimension to the challenges faced by public administration in the virtual realm. For example, acquisition of e-residency status in Estonia makes it possible to set up and remotely manage a company from anywhere in the world. In addition, the presence of an independent consulting firm registered in the United States makes it possible to establish an Estonian subsidiary using e-residency that can compete in the EU market. Virtual worlds are also related to digital twins. For example, **digital twins** enable city administrations to simulate and visualise **urban development** projects before implementing them. Virtual worlds technology has the potential to further improve the capabilities of digital twins and thus enhance public administration in cities through, for example, immersive visualisation or AR applications. For example, in a virtual world that represents the [city of Barcelona](#), public services related to urbanism or **mobility** will offer a great opportunity: should a citizen or a company want to ask for a construction or renovation permit, a virtual world could visually depict all the laws, restrictions and rules that are in place in the area, thus facilitating discussion with the city administration and making it more efficient. Virtual worlds can also assist in the efficient **management of city resources**, such as water, energy, and waste management systems. However, the sensitive characteristics of these infrastructures will lead to increased challenges when it comes to cybersecurity and data protection.



For this application, we expect **Scenarios 2 and 3** to be more prominent in the immediate future.

The **public safety and security sector** includes law enforcement agencies, fire departments and emergency medical services responsible for maintaining safety and order in society. Police officers and safety-related workers (e.g. firefighters) will take advantage of innovative virtual worlds to improve their skills through the simulation of critical situations that may not happen that often in the physical world. In addition to new or improved skills acquisition, virtual worlds can provide opportunities for different scenario simulations. These simulations can replicate various emergency situations, allowing personnel to practise their

responses, decision-making and coordination in a risk-free environment. In addition, virtual worlds can serve as a hub for simulating large-scale crises, such as natural disasters, terrorist attacks and pandemics. Virtual worlds can also be a valuable tool for engaging the public in different safety and security initiatives. Virtual town halls, educational experiences and interactive simulations can give citizens a deeper understanding of safety measures, emergency procedures and their role in ensuring community security.

Virtual worlds could offer unprecedented **opportunities for law enforcement** because – at least potentially – there may be access to all data exchanged on virtual worlds. However, access to that data will raise the challenge of **balancing the interests of fighting misconduct and privacy against other fundamental rights** (e.g. freedom of expression). Other legal challenges will result from the fact that interactions in the metaverse may not happen in any one physical jurisdiction. Parties will have the feeling that they are next to each other, but they could be physically present in many different jurisdictions, so a single crime could affect several jurisdictions (see also Section 6 on this point). A jurisdiction's sovereignty is in principle limited to its physical borders, so an agreement may be needed so that investigations can be conducted without violating the sovereignty of the other countries that are involved.

A crucial aspect of governing virtual worlds will be to **define the role of relevant private actors and their relationship with the public power**. Most of the responsibility for monitoring and moderating what is allowed on the platforms will fall on the private companies that own them and that will also have to provide law enforcement agencies with the tools to effectively operate on these platforms. Europol has stressed the need for active discussion with the main actors developing virtual worlds, and the need for **safety by design**. Innovative opportunities to prevent and prosecute offences will be particularly important as new ways of committing crimes appear. Virtual world activities that will constitute criminal offences include identity theft and fraud, financial crimes, offensive speech, terrorism, offences affecting children and phishing. Another **challenge will be to find perpetrators** and to enforce the law. This is not a new challenge, because this problem already exists to a significant extent on the internet, but it may be further exacerbated if platforms are based on increasingly decentralised and anonymising technology. Determining who is responsible in the physical world for crimes in virtual worlds will require a thorough understanding of the technology behind metaverses and how it differs from what came before.

For these applications we expect **Scenario 2** – via public procurement – to be more prominent in the immediate future due to the need for centralised control functions for public safety, law enforcement and the security sector.

Public services for **environmental protection** protect and preserve the environment. They include pollution control and natural resource management. Virtual worlds can be a powerful tool for raising environmental awareness. This can have a significant impact on, for example, noise and pollution emissions in an urban area. Virtual simulations, interactive experiences and educational content within the metaverse can help individuals learn about environmental issues, ecosystems and sustainable practices. More indirectly, virtual worlds have the potential to greatly enhance remote work by creating immersive virtual workspaces and enabling seamless collaboration, regardless of physical location. An increase in remote work could lead to reduced CO₂ emissions due to less commuter traffic.

For this application we expect **Scenarios 2 and 3** to be more prominent in the immediate future.

Images generated by DALL.E

3.3 Enablers that are crucial for the public sector

Supporting the above examples of innovative public sector applications in virtual worlds will require specific enablers. These enablers raise overarching questions that are relevant for virtual worlds more generally. They also require particular attention from a public sector perspective because public sector organisations might play different roles in ensuring that virtual worlds are used in a way that upholds the EU's values.

3.3.1 Multi-stakeholder participation

Depending on where and how these environments are deployed, the safe adoption of virtual worlds, technologies and tools will require the **consultation and the participation of all parties at the stages of evaluation and shaping of virtual worlds**. This includes city planners; engineers; schools and teachers; enterprises; and consumer and industry associations.

The EU could proactively steer the development of multi-stakeholder participation through dedicated multi-stakeholder activities, such as targeted public spending (e.g. procurement, grants and incentives) and targeted facilitation initiatives (e.g. dialogues, dedicated communities, accelerators, publications and events).

3.3.2 Technology

Technology will impact the way life will look in virtual worlds; how immersive the experience will be; what will be the possible types of activities; and how they will be performed. It is expected that virtual worlds will be a combination of various technologies. These will include extended reality (XR); AI (e.g. for personalisation through avatars and for analysing interactions or data); DLTs; neurotechnologies; cloud, fog and edge computing; optics; bio-sensing technologies; improved computer graphics; hardware; and network capabilities (Grady: 2023). These will be provided by platforms, so the concept of virtual worlds should not be tied to any specific existing technology. It is instead important to keep an open mind in this regard.

Connectivity infrastructure, computing (including cloud and edge computing technologies for processing and storing; and AI) and **5G** are also very relevant to enhancing the networks' efficiency, speed and latency, and traffic capacity. Virtual worlds will also be supported by the **Internet of Things (IoT)** – to transfer information between the real and the virtual world through connected objects; and **blockchain** – for decentralised financial transactions in virtual assets (Niestadt, EPRS: 2023).

To ensure solid metaverse-enabling infrastructure for the public sector, serious work needs to be done to improve **data connectivity** across the EU, so that the full potential of these bandwidth-hungry 3D environments can be exploited.

Each of these technologies raises specific questions on how they can affect EU citizens and that would inform regulation. In addition, for virtual worlds to be usable by the public sector and in the offering of public services, standards and other technical elements will need to be in place.

3.3.3 Interoperability and data portability

Interoperability is the basic **ability of different computerised products or systems to readily connect and exchange information** with each other in either implementation or access, and without restriction. Interoperability is enabled by using common technical standards for media, digital goods, virtual identities and communication protocols or for hardware compatibility between devices and consoles.

The right to **data portability allows individuals to obtain and reuse their personal data for their own purposes in different services**. It allows them to move, copy and transfer their personal data easily from one IT environment to another – safely and securely, and without affecting its usability.

Interoperability and data portability are key components of secure data exchange, which enables the public sector to offer digital public services. Data sharing and portability arise as users move between virtual worlds and within them, along with their data and assets. Data sharing agreements will be needed by companies that want proprietary rights over users' data. These agreements must meet data protection requirements, including user consent and privacy notifications. This may be difficult in virtual worlds with decentralised governance models (**Scenarios 1 and 3**). International transfers of data need to be clarified

in order to enable free movement in the virtual world. Determining jurisdiction can be challenging in virtual worlds, because jurisdiction can apply to a user's location, an avatar's location or a server's location.

3.3.4 Digital identity

Public services in virtual worlds could be useful for citizens and trustworthy, if a digital identity provides different layers of data:

- sensitive data with GDPR-enhanced consent: health and banking details;
- private data information with GDPR consent: gender and age;
- public data information: given name, surname, country and gender.

Various initiatives are currently being developed by the Commission to address these issues, for example [the EU Digital Identity](#) and the [EU Digital Identity Wallet](#).

3.3.5 User safety

Virtual worlds should be **a safe environment**. Safety in virtual worlds is particularly important, because of the deeper level of immersion. For instance, the risks and impacts of harassment or assault on mental health or even physical integrity could be greater or more distressing in the virtual world than in existing social media platforms. Examination of such created harms will therefore be necessary in order to reflect on how to regulate virtual worlds and enforce both specific and general laws. The **public remains generally sceptical about safety in virtual worlds**. If the EU wants people, public administrations and businesses to adopt these technologies, they will need to feel safe using them. This cannot be left entirely to policymakers. However, to earn their trust and ensure the successful deployment of a public virtual world, governments must ensure that their citizens can use a public service on any platform – including hybrid ones (Scenario 3) – with maximum safety and security. This will require policing of virtual worlds, while also making sure that this does not turn into a police state dystopia. **Users will have to be able to reliably verify the genuine identity of public authorities acting in virtual worlds** in order to prevent fraud and malicious actors posing as authorities.

Heightened and/or additional requirements would therefore be needed (e.g. more reliable identification of participants by their digital identities). Online anonymity is highly debated but already exists on private-sector platforms, and is even seen as a guarantee of freedom of expression in some cases. One could ask whether this anonymity should or should not be preserved in a public-sector virtual world. When it comes to specific public services offered in virtual worlds, the relevant authority's statutory obligations would have to be respected in the virtual setting too (for example, by embedding them by design in the system).

3.4 EU support for virtual worlds in the public sector

3.4.1 Local Digital Twin CitiVERSE EDIC

As part of the Digital Decade programme,² the Commission will put in place an innovative vehicle for a multi-country project with Member States and cities: a European Digital Infrastructure Consortium (EDIC) that will own and operate common infrastructures (i.e. cloud-based platforms) for cities' digital twins. This groundbreaking initiative is called the **Networked Local Digital Twins towards the CitiVERSE EDIC (LDT CitiVERSE EDIC)**. It opens the door for EU industry and SMEs to innovate and deliver a diverse array of data-driven services to foster liveable and sustainable urban environments by using trustworthy AI and virtual reality tools, including:

- making available AI solutions and predictive tools to create customised digital twins for urban planners;
- establishing national cloud-based infrastructures that provide digital twin capabilities to connect and provide services to cities and communities of different sizes, focusing on key policy scenarios and areas;
- making available local avatars that can simulate and visualise how a city can address real-world challenges, thus enabling inclusive citizen engagement.

The LDT CitiVERSE EDIC, which is due to be established by the end of 2024, will create a dynamic marketplace for industry (including innovative start-ups) to meet this demand and thereby generate opportunities for businesses across the EU and beyond.

The 11 founding Member State members of the consortium and the Commission are now pooling resources and knowledge, while drawing on existing EU deployment programmes to develop the initial infrastructure and structure their collaboration. More Member States will in the coming year join the consortium along with many cities and communities. Accession countries will also be able to cooperate. The LDT CitiVERSE EDIC therefore provides a unique place for pan-European collaboration on the digital transformation of smart cities and communities.

CitiVERSE calls in the Digital Europe Programme

The EU systematically funds development and deployment of virtual worlds for citizens through the targeted calls of the Digital Europe Programme.

With its 2022 CitiVERSE call, the EU supported a pivotal deployment action – the European Data Space for Smart Communities. Its vision revolves around creating a well-governed data space available to developers and infrastructure providers, in alignment with the prospects outlined in the EU's Digital Decade objectives. The European Data Space for Smart Communities aims to build a territorial, location-based data space for smart communities.

The 2023 CitiVERSE call was aimed at developing the CitiVERSE for citizens, offering them interoperable and sustainable services. The four projects stemming from this action, which will start in the second half of 2024, will help to define what the CitiVERSE means for the EU and to bring together the EU's CitiVERSE industry (including SMEs) in developing the different layers of VR/AR worlds useful for local authorities and citizens.

² The Digital Decade programme was established with EU Decision, 2022/2481.

4 Overview of the EU's legal framework

The EU can influence the development of virtual worlds through activities, such as targeted public spending (e.g. procurement, grants and incentives) and targeted facilitation initiatives. It can also do so by legislation. Legal considerations may steer various measures supporting the development of virtual worlds and they can help establish the overall governance framework and put required safeguards into place.

The scenarios described above and the possible applications of virtual worlds by the public sector prompt some questions with regulatory and policy implications. This section tackles them by providing a brief overview of the relevant EU legal framework and some analysis of its implications. This framework is particularly relevant in the short term, when Scenario 2 is expected to prevail. When a community-based virtual world (Scenario 1) or, more probably, a hybrid version (Scenario 3) becomes more prominent, the relevant rules are likely to remain the same but their relative balance within the overall legislative framework might change. This section is not intended as a comprehensive legal analysis of the applicable EU legislation, but rather as a way to highlight relevant legislation and elements that are important for the use of virtual worlds in the public sector.

In particular, the rules enacted in recent years by the EU (including on privacy, online content moderation, market power and artificial intelligence) are likely to **apply to the new field of virtual worlds, especially horizontal regulations like the General Data Protection Regulation (GDPR), the Digital Services Act (DSA), the Digital Markets Act (DMA) and the AI Act**. Their objectives include the protection of users and ensuring a level-playing field for companies – particularly for the EU's SMEs (including start-ups) so that they are not driven out of the market.

The EU recently adopted the **Regulation on Markets in Crypto-assets (MiCA)**, which is also relevant to regulating some technologies that support virtual worlds. When it comes to law enforcement, many EU norms³ might be applicable and will require further analysis to assess whether amendments are needed.

Several of these legal acts are already useful for addressing the challenges of virtual worlds' new technologies (as illustrated in Section 2 on the three scenarios). Most of these laws were drafted before virtual worlds were even a widely used policy and political term, so

³ In particular:

- Directive 2013/40/EU of the European Parliament and of the Council of 12 August 2013 on attacks against information systems;
- Directive (EU) 2019/713 of the European Parliament and of the Council of 17 April 2019 on combating fraud and counterfeiting of non-cash means of payment;
- Directive (EU) 2017/541 of the European Parliament and of the Council of 15 March 2017 on combating terrorism;
- the current and future anti-money laundering framework (the 4th and 5th AML Directives, the Criminal Law Directive and the proposals for amendments to that framework);
- Regulation (EU) 2023/1543 of the European Parliament and of the Council of 12 July 2023 on European Production Orders and European Preservation Orders for electronic evidence in criminal proceedings and for the execution of custodial sentences following criminal proceedings;
- Regulation (EU) 2018/1805 of the European Parliament and of the Council on the mutual recognition of freezing orders and confiscation orders;
- Directive (EU) 2016/680 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data by competent authorities for the purposes of the prevention, investigation, detection or prosecution of criminal offences or the execution of criminal penalties, and on the free movement of such data (the Law Enforcement Directive).

their **ability to remain relevant to virtual worlds should be continuously monitored**, particularly as regards privacy, safety and cybersecurity safeguards. Some of their requirements **may need updates in the future to address the new emerging reality** that encompasses the digital and physical worlds. Such a comprehensive analysis of the suitability of EU legal frameworks applicable to virtual worlds will require further research. A critical challenge will be for the EU to ensure that **all stakeholders in virtual worlds comply with the relevant digital legislation and competition frameworks** in the first place.

The **GDPR** applies to the processing of personal data and therefore to the collection and use of user data in virtual worlds. The European Parliament has called for a potential revision of the data protection framework (Arias Echeverría, 2022/2198(INI), 5 December 2023, paragraph 13). It has urged the Commission to ensure that companies and entities operating in virtual worlds comply with the existing legal framework. Policymakers should use a forthcoming review of this Regulation to **ensure that stakeholders involved in virtual worlds abide by the GDPR**. In light of the feature of virtual worlds, the EU should also use this forthcoming revision to further explore the challenges and complexities around user consent that did not exist when GDPR was crafted. Data collected during unconscious behaviour or by AI also need to be regulated.

The **AI Act** regulates the use of biometrics or certain techniques that would apply in virtual worlds. The **DSA**, which governs the EU's content moderation rules, covers illegal or harmful elements that would probably be a risk for metaverses and will therefore probably apply to many developers and users operating in those environments (Madiega et al., EPRS: 2022). It is nevertheless likely that **both the AI Act and the DSA will have to be monitored and updated to clarify their link with virtual worlds**, thereby ensuring that they continue to protect users and do not become obsolescent.

The EU could **strengthen protection against illegal or harmful content** by helping online companies and law enforcement authorities to better identify and respond to these issues in virtual worlds – such as by the application of specific norms⁴ and by **issuing guidelines**.

Any ongoing or new EU initiative, such as the **AI Liability Directive**, should also be assessed on their links with virtual worlds. **Liability laws that apply** to online companies should be clarified so that these stakeholders can be informed about and consider the potential impacts if they provide users with metaverse-enabling technologies or infrastructure (Castro, ITIF: 2022).

The requirements of interoperability and data portability will mean that corporations and public actors that operate in virtual worlds will set up **data sharing agreements**. These agreements would have to comply with current EU data protection requirements (particularly those of the GDPR), such as user consent and privacy notifications. The **Data Act and the Data Governance Act (DGA)** are likely to be relevant here as well, because they aim to incentivise data holders to enter voluntarily into data sharing agreements (including for public data). Furthermore, the **Data Act** enables the Commission to promote

⁴ In particular:

- Regulation (EU) 2021/784 of the European Parliament and of the Council of 29 April 2021 on addressing the dissemination of terrorist content online;
- Directive 2011/93/EU of the European Parliament and of the Council of 13 December 2011 on combating the sexual abuse and sexual exploitation of children and child pornography;
- the final text that might be adopted for the proposal for a regulation of the European Parliament and of the Council laying down rules to prevent and combat child sexual abuse.

the interoperability of data spaces and enhances the portability of digital assets. However, the implementation of these two laws should be carefully monitored in order to ensure that it is efficient. Stakeholders should be advised to check that the agreements are valid if they involve applications or technologies used in virtual worlds.

Data will probably be transferred internationally through virtual worlds, so data movement in virtual worlds should be clarified. This will involve **reviewing existing international data transfer agreements**, such as the new EU-US accord or data protection adequacies with third countries. It will also be key to clarify **which jurisdiction should be assigned** to the location selected – that of the user, of its avatar or of the relevant servers.

Existing EU rules help to govern virtual worlds as regards competition frameworks.

The **DMA** is still in the early implementation stage, and addresses potential issues that could emerge, if for instance virtual worlds companies were to prioritise their own content at the expense of others (self-preferencing) or to refuse access to their space. The DMA can help ensure that the most economically powerful platforms (known as 'gatekeepers') remain open and contestable to the whole market through provisions that require interoperability (Di Porto and Foà, CERRE: 2023). Under the DMA, the Big Tech companies are currently designated as gatekeepers only for the services where they are already dominant and not for their potential new services (e.g. new virtual worlds). However, the DMA does foresee the notion of 'emerging gatekeepers', whereby the new services of those companies could be monitored and potentially labelled as gatekeepers even before they reach the critical levels of dominance. This aspect of the DMA is highly relevant in the context of newly developing categories such as virtual worlds; and **it is essential that the competitive landscape is systematically monitored for any 'emerging gatekeepers'** in this domain, and that relevant actions are undertaken in a timely manner.

Virtual worlds will raise questions regarding the topics of online anonymity and authentication of identity. A seamless VR between digital and physical worlds could be provided on the users' interface, so identities could 'merge' (i.e. be considered equivalent in both the digital and physical worlds). This would entail certain risks, so a digital identity connected to virtual worlds would have to be adequately protected and governed. Another piece of the EU legislative framework that would probably be relevant for virtual worlds is therefore [the EU digital identity](#), adopted in 2024. Indeed, it will provide a useful framework for addressing some issues related to the level of involvement of private sector identity providers in virtual worlds.

For safety and cybersecurity reasons (and other reasons), it will be necessary to find and include ways for users of virtual worlds to **prove that they are human**. As a basic example, captchas have proliferated to filter out bots and automated agents and prevent them from filling out forms intended for human users. A digital identity used in virtual worlds should make this possible.

Other existing EU laws or related initiatives that could apply to virtual world environments include:

- the EU's **Interoperable Europe Act** – because it applies to the provision of trans-EU public services and measures that support their development and seamless interaction;
- the EU's **copyright norms** – because they probably apply to the use of copyrighted material in virtual worlds, such as music or art;
- the EU's **Audiovisual Media Services Directive (AVMSD)** – because it applies to certain types of content in virtual worlds, such as video or audio content that is streamed or broadcasted;

- the **Public Sector Information (PSI) Directive / Open Data Directive** and high-value data sets – because they set the baseline for public sector organisations for the provision of open data for reuse;
- the EU's **Cybersecurity Act** – because it establishes the cybersecurity certification framework.

In addition to regulatory frameworks and considerations, information, education and awareness-raising should always remain a priority. To ensure user autonomy and empowerment of citizens in their use of virtual worlds, the EU should update its framework for **digital skills and digital literacy** (Hupont Torres et al., 2023) in order to better inform EU Member States about how these frameworks (and relevant funding) can be targeted and made relevant to virtual worlds.

5 Deep dive into the CitiVERSE: a specialised instance of virtual worlds

This section takes a deep dive into a specific instance of virtual worlds – the CitiVERSE, which is one of the most advanced examples of virtual worlds with a clear public sector and public policy dimension. This case study shows in operational/concrete terms how the scenarios set out in Section 2 could materialise in the short and medium terms. This allows a deeper analysis of key enablers and challenges related to the use of virtual worlds in the public sector. Moreover, by imagining how a CitiVERSE could be implemented in practice, this section focuses on a limited set of regulatory and policy questions (e.g. ethics and fundamental rights; power and governance issues; technical requirements; and standardisation needs) that are likely to be relevant to other applications of virtual worlds by public authorities. In line with the approach taken elsewhere in this report, those issues are linked back to the EU legal framework. This will serve as a basis for identifying possible areas where experimentation (e.g. through regulatory sandboxes) would be useful in order to ensure that legislation remains future-proof and supportive of innovation in line with EU policy objectives, such as those of the Digital Decade.

5.1 Innovation opportunities and selected applications for the CitiVERSE

5.1.1 The EU CitiVERSE: definitions and innovative opportunities

In the years ahead, the CitiVERSE is expected to be an important component of the Digital Decade programme through which the Commission aims to pursue a ‘human-centric, sustainable vision for digital society throughout the Digital Decade to empower citizens and businesses’.

Inspired by the ISO/IEC 23005-1:2020 and IEEE 2888 standards (Yoon et al., 2021), the CitiVERSE has been defined as a series of interconnected and distributed hybrid and virtual worlds that represent and are synchronised with their physical counterparts. It offers new (administrative, economic, social, policymaking and/or cultural) virtual goods/services/capabilities to city and community actors (e.g. citizens) that are represented as digital avatars. The CitiVERSE concept is rapidly evolving, so new developments might occur in the future that will be reflected in different definitions.

Both the terms ‘CitiVERSE’ and ‘metaverse’ relate to virtual environments but seem to have distinct meanings and implications. The CitiVERSE generally refers to a virtual space or

environment specifically designed to replicate and represent real-world cities or urban environments. It focuses on community actors (including citizens, policymakers and local authorities) and aims to create digital replicas of real cities, allowing users to explore and interact with these virtual urban spaces. The CitiVERSE often revolves around urban scenarios (e.g. city planning, urban development and other urbanistic interventions) that could be turned into immersive experiences or simulations. However, definitions of the CitiVERSE concept in the EU context are still evolving.

The vision of a CitiVERSE is articulated in a draft document that is intended to support future standardisation efforts and provide recommendations to facilitate its effective establishment (Alvarez Rodriguez et al., 2023):

‘The European Commission aims to promote an inclusive and sustainable CitiVERSE, setting leading benchmarks for equality, decentralised governance, sustainability, and well-being (COM(2023) 442/final). The CitiVERSE must be designed and developed on decentralised, technology-agnostic, open, user-centric and accessible platforms and reflect the values, principles, and fundamental rights of the EU. The aim is to create citizens’ centric environments where consumers, workers, and/or creators are respected, and European businesses can thrive, scale and grow. It should offer opportunities to public authorities and urban planners to better serve their citizens and make use of evidence-based decisions using Web 4.0 technology. Open standards and interoperability between networks and platforms are essential to ensure user freedom, digital ownership, cross-platform activities and economic opportunities. Competition and innovation among providers need to be sustained for CitiVERSE ecosystems to become more diverse and richer.’

The Commission will support the European CitiVERSE as a ‘flagship project of public interest’ that aims to optimise spatial planning and management; and take social, architectural, sustainable and cultural heritage dimensions into consideration (COM(2023) 442 final). It thus aims at improving the quality of life in cities by addressing social and environmental challenges. These include nature-based solutions; sustainable transportation; food security; efficient energy consumption; community engagement; and smarter urban systems (e.g. education, healthcare, waste management and risk management). Driven by today’s challenges, the development of the CitiVERSE has connections with and implications for the achievement of the Sustainable Development Goals (SDGs), the European Green Deal and the [initiatives for EU cities and urban development](#).

The future CitiVERSE could also be integrated into a framework along the lines of [Society 5.0](#), which represents a shift to an ideally just and sustainable society that is to be achieved through a high degree of convergence between cyberspace and physical space. The purpose of Society 5.0 is to improve people’s well-being through cutting-edge technology, so the CitiVERSE may play a significant role in this society.

5.1.2 Applications of the CitiVERSE

The CitiVERSE can combine extended reality (XR) in hybrid worlds with the idea of local digital twins to replicate and represent real-world cities or physical environments. A digital twin is defined as a model that is as close as possible to a physical system and can therefore be used for many practical purposes (Caldarelli et al., 2023). Local digital twins are being used to represent the physical (infra)structure of complex systems, such as cities (but also products and persons) in an increasingly detailed and realistic way (Caldarelli et al., 2023). The digital twin shares information with its counterpart physical system in terms

of its inputs and outputs. The physical system and its digital twin work in concert, so the digital twin can inform, control, assist and enhance the physical system. Therefore, to build a CitiVERSE on top of local digital twins, the first step for many cities is to improve data collection, retention, quality, integration and analysis capabilities; and then add XR visualisations (see Annex 2 for further details). AR/VR features could typically be implemented on the basis of existing urban data platforms or digital twins that would provide the needed underlying capacities.

The CitiVERSE can thus become a central point for local and regional governments to drive forward future city developments successfully and sustainably. Cities and communities can engage in the CitiVERSE in several activities relevant to policymaking. During a workshop organised by the technical subgroup of [Living-in.eu](https://living-in.eu), which seeks to boost sustainable digital transformation in cities and communities in the EU, the following activities were listed as possible in social policy:

CityVerse use cases (examples)	Possible activities in social policy
Modelling urban heat islands (integrating several data sources)	Designing, simulating, contributing, deciding, operating, collaborating, transacting, socialising, experiencing, communicating and learning
Simulating urban floods	
Improving traffic control rooms	
Enhancing public virtual safety	

5.2 Specific scenarios for the CitiVERSE

It is not known exactly how the CitiVERSE will develop in the next 10 to 15 years. However, in addition to the envisaged scenarios for the future of virtual worlds in general (see Section 2), the following three scenarios are considered for the specific case of the EU CitiVERSE (depending on the degree of acceptance and technological development):

1. The CitiVERSE is used as aesthetically appealing technology to enable policymakers and citizens to visualise the current and specific city issues and potentially predict the likely effects of changes.
 2. The CitiVERSE is used as a practical tool in order to choose from different simulated complex policy settings for policymakers and citizens. Citizens are part of the simulation. Complex systems modelling is needed.
 3. The CitiVERSE is widely accepted as a policy-testing tool (as above) and participation of citizens is automatised by brain-reading or similar interaction technologies, leading to collective decisions. Ethical considerations regarding the interpretation of brain signals and their consequences need to be considered.

This section explores how the CitiVERSE could be implemented in the proposed specific scenarios, describing three different levels of citizen involvement in development and experimentation for policymaking. The analysis of the scenarios is based on a citizen-centric perspective (Vesnic Alujevic et al., 2019) that approaches policymaking and the delivery of public services with a primary focus on the needs, rights and interests of individual citizens. This perspective places citizens at the centre of decision-making processes in order to create more responsive, inclusive and effective policymaking and delivery of public services. Placing citizens at the forefront not only makes it possible to consider hypothetical scenarios of how to use the CitiVERSE (along with interactions

between citizens, public institutions and the private sector), but could also help start a dialogue about the potential forms of governance of the CitiVERSE that might be pursued in the future.

Specific CitiVERSE Scenario 1 involves the possibility of **local authorities** sharing information with citizens (for example, on issues at the local level). Local authorities use methods of participation by informing and consulting (IAP2, 2016). During consultation, citizens contribute their viewpoints, opinions and preferences; and authorities feed this information into their decision-making. In this scenario, the public can be involved in the CitiVERSE for purposes such as:

- informing and educating citizens on specific city issues that policymakers consider important;
- increasing the awareness of citizens of urban projects, interventions and initiatives;
- improving the image of city institutions in the eyes of citizens.

Citizens can be exposed to different types of data (e.g. observational, spatial, tabular and multimedia) and can be involved in different forms of interaction for data visualisation in the CitiVERSE (e.g. interaction for visualisation using haptic controllers or other senses to perform various manipulations; and interaction for visualisation using various channels to perceive the results of an interaction) (Zhao et al., 2022).

Specific CitiVERSE Scenario 2 involves a higher degree of citizen participation than in Scenario 1. Policymakers and other stakeholders (e.g. political leaders, urban planners and real estate developers) can involve citizens in collecting data useful for simulation and forecasting. Simulations involve the use of computational models to provide evidence for decision-making by enabling the testing of different settings or process changes. Coupled with virtual reality technologies for more immersive experiences, simulations can provide insights into a wide range of issues at the local and regional levels. One example is urban flooding, which requires intensive data collection. Citizens can contribute data for modelling and forecasting. Crowdsourced data can be integrated into modelling to improve performance and directly feed into the models to improve forecasting results (Assumpção et al., 2018). These models can provide governments, local authorities and the public with evidence on which to base different responses to environmental disasters (e.g. floods, landslides and fires) that could be better designed and implemented.

Specific CitiVERSE Scenario 3 does not specify whether the CitiVERSE is widely accepted by everyone (including citizens) or mainly by policymakers as a policy-testing tool for experimentation and development. Depending on whether the former or the latter is the case, Scenario 3 involves different ethical and policy implications. Brain-reading and similar technologies can be used to record users' minds (in order, for example, to improve service delivery) by also recording what they perceive while immersed in the virtual experience. It should be noted that reliable brain-reading technologies are theoretically feasible but are very futuristic and unlikely to be available in the near future. This report therefore only considers them for completeness of analysis. Citizen participation is characterised by passivity, perhaps due to limited awareness or understanding of this technology. This could lead to a sense of powerlessness in influencing decision-making processes related to these emerging technologies. Embodied experiences allow full interaction with features of the virtual environment and, in social or multiuser environments, with other individuals in the virtual space. Critics caution that, from the vantage point of the user's brain, what happens in XR is an actual reality: 'When scientists have measured brain activity in MRIs, they have found that, when a user experiences a virtual event and subsequently recalls it, the response in the hippocampus is akin to the way one would predict the brain to respond to an actual event. Psychological realness also causes immersive technology users to

physiologically respond to virtual simulations in ways that are similar to their bodily responses to real situations.’ (Heller, 2020, p. 23). In addition, the study of emotions is not yet sufficient to be the basis for reliable decision-making. A high perceived risk of automation using brain-reading technology is very likely to worry citizens and reduce their willingness to participate.

Specific CitiVERSE Scenarios 1 and 2 appear realistically practicable. Specific CitiVERSE Scenario 3 is much more theoretical – not only in terms of the current stage of technological development, but also in terms of risk-benefit considerations. In any event, the actual implementation of these scenarios hinges on critical factors such as the establishment of a sustainable ecosystem of stakeholders and the development of a robust connectivity infrastructure that prioritises energy efficiency. It is worth noting that the current computing power may prove insufficient for the full realisation of CitiVERSE simulations, given their potential incorporation of energy-intensive technologies (e.g. digital twins and advanced AI models) that are designed to increase realism, interactivity and decision-making capabilities.

Addressing the challenge of levelling the playing field is vital to developing an EU-wide inclusive CitiVERSE. In the context of citizen participation in policymaking using the CitiVERSE, legislative measures should be implemented to prevent the exacerbation of digital divides in the EU. Disparities in access, skills, motivation, location, usage context and opportunities must be considered. Specific segments of society may face additional disadvantages (e.g. socio-economic, educational, ethnic, age, gender and geographical) that hinder their ability to take full advantage of the opportunities presented by the CitiVERSE. Digital divides result from factors such as governance, institutional frameworks, regulations, the labour market and the broader economic system; and do not result directly from technologies. However, an unequal implementation and use of the CitiVERSE for policymaking and delivery of public services can intensify such digital divides (Millard, 2023).

A human-centric and rights-oriented development of the CitiVERSE is necessary in order to foster a fairer and more sustainable use of these technologies. This approach transcends mere technological capabilities and, importantly, should be advocated not only **for** but also **by** people.

5.3 Potential benefits of the CitiVERSE

Urban planning and environmental sustainability. In the Specific CitiVERSE Scenario 1, the CitiVERSE could be used in accordance with the concept of the proposed New European Bauhaus (NEB). This is a 2021 Commission initiative to make cities sustainable, inclusive and beautiful, thus improving citizens’ quality of life. Digital twins can be used to represent the physical and environmental characteristics of cities and regions. In this scenario, the digital twin could be used primarily for aesthetically appealing data visualisations (for example) but could also enable limited interaction with citizens. The NEB initiative embraces three core values (**beautiful, sustainable and together**) to shape innovation within ecosystems that affect the development of cities. The CitiVERSE used in this scenario should take into consideration dimensions that are aligned with those values. Places, practices and experiences in the CitiVERSE can be considered beautiful if they are (EC, 2021):

- **enriching:** inspired by art and culture, responding to needs beyond functionality;
- **sustainable:** in harmony with nature, the environment and our planet;
- **inclusive:** encouraging a dialogue across cultures, disciplines, genders and ages.

The real-time rendering process (where rendering means the creation of computer images) can be aligned with the NEB's values. The CitiVERSE can be designed to generate appealing synchronous virtual worlds in response to human input; to inform citizens and to obtain their feedback on options or decisions to build greater social acceptance for Green Deal policies that, for example, promote social ownership of green solutions and encourage behavioural changes needed to meet Green Deal targets.

Quality of human experience. It is worth noting the role played by **aesthetics** (i.e. the quality of human experience). The NEB sees aesthetics as a value that is inseparable from digital transformation (EC, 2021). The CitiVERSE can therefore become a good environment for citizens if it retains some important aspects of our humanity. Our feelings about our perceptions matter. **Aesthetics offer the opportunity to enrich the digital twin beyond functionality by including humans' core motivations.** Merely representing physical reality is unlikely to influence people's intentions, behaviours, characteristics and interactions (Caldarelli et al., 2023). People cannot experience virtual worlds with all five senses. However, sight and sound – which dominate virtual world experiences – might be sufficient to make their experiences meaningful (Aesthetics Research Lab, n.d.).

Citizen engagement and participation in urban development. In each of the three Specific CitiVERSE Scenarios, the CitiVERSE can involve citizens in new experiences, providing platforms for testing experimental solutions to urban problems. For example, the CitiVERSE can be used to involve local participants in the redesign of public spaces. The CitiVERSE can be used in different ways and at different scales to engage citizens, starting with a contributory role (e.g. collecting reactions to a particular policy option) and fostering participation beyond this role by creating listening mechanisms to incorporate citizens' ideas, expectations, values and imaginations into planning, decision-making and policy decisions (Gumaraes Pereira et al., 2020). Simulations of testing policy environments should include not only listening mechanisms but also options to engage and co-design future scenarios.

The main emphasis of e-government has traditionally been on effective service delivery, but there has been a noticeable shift towards its use in two emerging areas: (1) fostering communication between governmental and local authorities and citizens through e-consultation; and (2) involving citizens in policy decision-making and collaborative service creation through e-decision-making (Toots, 2019). In Specific CitiVERSE Scenario 2, individuals may find themselves in a more equitable and collaborative position with policymakers, which would make it more likely that their contributions will be incorporated into the decision-making process than in Specific CitiVERSE Scenario 1. Citizens can participate in simulated complex case settings in order to increase their awareness of urban issues and public sector strategies; express their priorities; see the consequences of experimenting with different trade-offs; deliberate on their options on certain urban planning choices; and then submit their considered preferences. The result can be insightful feedback that is digitally recorded, officially acknowledged and fully linked to the virtual space, thus making it more valuable for policymakers and decision-makers.

5.4 Specific considerations towards creating a EU CitiVERSE

Global regulatory competition. It is imperative that EU regulations proactively define permissible actions, and that regulations and standards progressively expand as uses within the CitiVERSE evolve. Drawing inspiration from the early days of the internet, when the US Federal Internet Engineering Taskforce played a pivotal role in standardising protocols such as TCP/IP, the establishment of similar taskforces at the EU level would be

instrumental in defining the role of public administration within the CitiVERSE. Harnessing the full potential of the CitiVERSE is a challenge for the public sector in the different EU Member States. National public sectors must carefully weigh up the costs of addressing legacy IT issues and managing data, taking into consideration the necessary investments in technology acquisition and staff training for technical and managerial proficiency. Sharing costs with other authorities and/or using technologies developed by private companies may be crucial elements in this process.

In a more recent example, the United States has ensured platform interoperability through the Augmenting Compatibility and Competition by Enabling Service Switching Act (H.R.3849 – ACCESS Act of 2021). Interoperability is paramount for fostering collaboration and establishing standards among various public and governmental entities that use the CitiVERSE. Standardising guidelines and specifications is expected to enhance efficiency, generate cost savings and improve interoperability, positively influencing practices related to technology procurement and implementation within the public sector.

Local and national governments will also need to figure out how to use virtual spaces in the CitiVERSE to communicate with citizens and engage them in policy experimentation economically, legally, and technologically. When using the CitiVERSE as a tool in municipalities, regions and EU countries, it could be a challenge to determine where jurisdiction lies for legal disputes and law enforcement actions in the CitiVERSE, which can transcend physical borders. International agreements and further regulations may be needed to address these issues.

New privacy-related harms. Advocates of the metaverse, including businesses, often see it as a transformative technology with significant potential in various industries. As evidence of VR's promise, supporters often cite enhanced human connections, increased empathy and greater educational possibilities. It is nevertheless important to temper optimism and point out potential misuses and abuses, such as harassment and privacy violations (Heller, 2020). The significant and personal impact of immersive technologies underscores the profound risks they pose for individuals and society. These risks require careful regulatory consideration. These and other similar concerns also apply to the CitiVERSE.

Blockchain thinking. The development of blockchain thinking is outlined as an input-processing-output computational system. Blockchain thinking might be used when working with digital mind files (uploads of full human mind files) in the future. As noted by Swan (2015), these data can be collected through various means, including intracortical recordings, human electroencephalography (EEG) and brain-computer interfaces. By logging these data transactions, the foundation of a person's thoughts could be established on a blockchain, encompassing their entire subjective experience and potentially even their consciousness. Once stored on the blockchain, different components of the encoded thoughts could be managed and traded. The possible emergence of such an application is **full of risks** and requires, at the very least, strong trust and verification mechanisms in order to gain user acceptance. Effective legal instruments and experimentation in regulatory sandboxing must therefore be provided in order to ensure that the protection of fundamental human rights prevails over business interests. This is also recommended by the Council of Europe (2023).

Accessibility and inclusion. The CitiVERSE, which functions as a platform that encourages inclusive and collaborative participation, has the potential to generate extra value by promoting the development of diverse and inclusive urban spaces for local residents, the wider community and various stakeholders. However, in order to realise these objectives, the CitiVERSE must prioritise considerations of accessibility, diversity,

equity and inclusion. These considerations should encompass the following principal elements.

- Accessibility and design for all: removing the barriers that create undue effort and separation by addressing a broad range of issues. These include accessibility for people with disabilities; access to and quality of hardware, software, and internet connectivity; education; gender; geographical location; culture; and age (including older and younger people).
- Economic accessibility: making hardware (e.g. VR headsets) more affordable and avoiding the CitiVERSE becoming too energy-heavy for individuals and society.
- Giving value to people: giving them a sense of purpose and a meaningful role to improve their experience within the CitiVERSE and ultimately increase their acceptance of this virtual world.
- Addressing digital equity through public communication and education around the use of the CitiVERSE in order to prevent exclusion due to tech advancements, as well as to receive public input and ensure legitimacy.

Ethical implications of using the CitiVERSE. The CitiVERSE has vast potential to introduce innovation into the public sector. This technology presents numerous opportunities for societal advancement. However, the deployment of such powerful tools requires a foundation in robust ethical principles. Designing an inclusive CitiVERSE should involve respecting human values and ethical principles; and technologically responsible design. A critical concern is the possibility of granting companies unrestricted access to personal data. To address this risk, measures should be implemented in order to ensure that only essential data are collected. Limiting data collection to what is necessary for its intended use reduces the volume that needs processing and storage. Compliance with the EU's General Data Protection Regulation (GDPR) is imperative.

Building trust in the technologies underlying the CitiVERSE is critical. Citizens can be concerned about the security and reliability of XR, VR and AI applications. The use of brain-reading and related technologies envisioned in Specific CitiVERSE Scenario 3 gives rise to specific concerns, including privacy, potential misuse and ethical implications regarding manipulation or intrusion into individuals' thoughts and cognitive processes. The exposure of one's mind to scrutiny raises concerns about the loss of free deliberation and self-conception, compromising private reflection (Reardon, 2023). **Complying with human values and ethical principles means avoiding technologies that pose potential 'unacceptable risks',** such as brain recording (as stated by the AI Act). **Legislation should proactively establish clear legal boundaries for the permissible uses of brain recording technologies.** When addressing such potentially hazardous technologies, it is essential to apply the proportionality principle in order to ensure that the benefits justify the risks and that the measures taken are appropriate and balanced.

It is also of crucial importance that platforms and tools are secure, with measures in place to safeguard individuals' privacy and set clear boundaries, especially concerning emotion recognition and biometric identification. Privacy issues arising from automated decision-making and a lack of transparency in algorithms associated with these technologies must be actively confronted and resolved. Drawing on a precedent, policymakers can consider a 2008 US law that prevents discriminatory use of genetic information by insurers and employers (Reardon, 2023). Concerns also arise for individuals with conditions like obsessive-compulsive disorder, who may experience intrusive thoughts in the context of the immersive and interactive nature of the CitiVERSE or VR environments.

The significant computational power and energy required by the CitiVERSE make ethical environmental considerations paramount. For example, Meta was in 2022 reported to have planned a data centre in the Netherlands to host a portion of their virtual world in the EU with an expected energy consumption of 1 380 gigawatt-hours per year. This single data centre would consume nearly half as much energy as all other data centres in the Netherlands combined.

Local and national authorities must address the issue of sourcing energy and computing power required to enable the CitiVERSE and the cost barrier for users. Before undertaking large-scale projects, issues related to the carbon footprint and the sustainability of CitiVERSE infrastructure must be carefully weighed against those for similar physical world products.

Power considerations and citizen acceptance of the CitiVERSE. Citizen participation in the CitiVERSE hinges on how citizens perceive, experience and trust it. Those responsible for developing and overseeing the CitiVERSE, such as public institutions and the private sector, must understand the factors that influence civil society and citizen acceptance. They should tailor interventions (including participant training) to address the specific concerns of citizen groups that are less inclined to engage in simulations. To ensure that CitiVERSE environments are crafted with user value and acceptance in mind, it is essential to employ value-sensitive design (Friedman et al., 2017). This approach goes beyond technical features (e.g. 3D graphics, immersive experiences and invisibility) and considers human values, needs and practices during the design and development process. The acceptance of citizens could be hindered by a technocratic perspective, in which decision-making and governance are predominantly led by experts or technocrats that rely heavily on technical or scientific expertise. This method has its advantages but may make it harder to gain citizen acceptance for a number of different reasons. These include a perception of tokenistic 'box-ticking' participation; the complexity of the system; lack of transparency; perceived detachment from the specific needs and concerns of citizens; and resistance to change. Previous investigations into online civic engagement have mainly focused on technological aspects (Epstein et al., 2014). However, merely providing interactive technology to citizens does not ensure their substantial and meaningful engagement (as emphasised in the UN global reports on e-government and e-participation in 2020 and 2022). Negative reactions to technology can impact citizens' acceptance of the CitiVERSE and not just those with limited digital skills.

Prioritising the well-being of individuals and their real-world experiences plays a crucial role by emphasising the importance of human interaction and control over digital elements. For example, a notable gap in current research on e-participation is the lack of connections between citizen e-participation activities and various contextual elements. These elements include political, institutional, legal, organisational, socio-economic and other factors that may influence the implementation and outcomes of e-participation processes (Durman et al., 2022). These contextual factors can be more significant than technical characteristics and should be considered when planning citizen engagement in policymaking in the CitiVERSE. Digital components can enhance public values, but there seems to be a need for forms of 'digital sanitisation', involving audits to eliminate or reduce digital elements that do not contribute value but instead worsen digital divides (Millard, 2023). This approach would ensure that the use of the CitiVERSE aligns with public interests without compromising human-centric values.

It is crucial to consider the substantial influence exerted by the Big Tech companies. These companies have the potential to fill gaps in state, market, and research and development. They can significantly impact socio-economic development but have limited political accountability. This highlights the need to envisage revisions to antitrust laws, as discussed

in Madiaga et al. (2022). Big Tech players can therefore compromise the visions guiding local urban transformations and citizens' voting and decision-making mechanisms.

Governance. The vision of the CitiVERSE described in subpoint 5.1.1 involves a decentralised structure. As stated in subpoint 2.1.1, governance broadly refers to the multiple actors who, with varied responsibilities, assume accountability for and oversight over the CitiVERSE. This idea of governance is consistent with the implementation of a polycentric approach (Ostrom, 1991) that is based on decentralised decision-making. As formulated by Ostrom (1991: 225), a polycentric system would be composed of **many autonomous units that are formally independent of one another and act in ways that take account of others through processes of cooperation, competition, conflict and conflict resolution**. Decentralised governance systems that autonomously organise themselves can show greater adaptability without requiring the need for central or external planning or guidance.

The three Specific CitiVERSE Scenarios suggest a policymaking and decision-making process that can evolve beyond the traditional dominance of a single entity (e.g. the state or local authority) and relies more on the interactions within diverse networks that involve both public and private actors. **A decentralised process is more likely to enhance the resilience, adaptability and relevance of interventions by distributing decision-making responsibilities instead of depending on a singular authority that enforces a command-and-control form of governance**, where a centralised team has authority, responsibility and control over data access decisions and resources. However, decentralised governance might give rise to tendencies to participate in predatory actions (e.g. trying to misuse power or authority to mistreat or take advantage of others) and to overlook duties associated with delivering public services. Interactions between cooperative moral individual and organisational actors within the CitiVERSE should therefore be reinforced. This is especially the case in Specific CitiVERSE Scenario 3, where the prospected use of brain-reading or similar technologies in the context of policymaking reflects the idea of blockchain thinking (Swan, 2015).

Technology offers opportunities to redefine governance and prompts an examination of the potential contributions of emerging technologies (such as blockchain and DLT) to foster effective and legitimate governance mechanisms (Goldberg & Schär, 2023). The aim is to encourage innovation; support the compatibility of technical solutions and platforms; and maintain a balance between stakeholders' different interests. It is therefore critical to ensure the representation of multiple stakeholders by establishing a governance structure that seeks to include public and private sectors as well as citizens. However, the challenges associated with implementing a governance scheme involving multiple stakeholders should not be overlooked. Establishing mutually beneficial relationships and providing adequate incentives for all involved parties is crucial.

5.5 Enablers of the CitiVERSE

The CitiVERSE is a technological innovation that can be used for innovative policymaking while attempting to ensure respect for the EU's rights and principles (EC, 2022). Based on the analysis of the three Specific CitiVERSE Scenarios and considering such rights and principles, we discuss the following key socio-technical enablers, which cut across the three scenarios and span technological, individual and societal aspects. This section delves into the technological and societal aspects that could enhance the functionality of an open and decentralised CitiVERSE. It does not consider the many contextual factors that might influence the operation of the CitiVERSE, including its goals and the socio-economic environment in which it is developed.

Trust. Decentralised governance structures are often associated with technologies like blockchain and DLT. These technologies can help build trust among participants in the CitiVERSE, because they use cryptographic principles and decentralised consensus mechanisms to enable secure and verifiable transactions without the need for a trusted third party.

However, public authorities need to build **trust both within and outside virtual worlds**. Increasing communication; emphasising local needs and issues; establishing more frequent contact with local communities through community events and visits; and exchange programmes with other local authorities and educational institutions could help build a sense of proximity and trust at the city and community levels.

Using the CitiVERSE for citizen involvement does not automatically increase citizens' trust in their governments and local authorities. Public institutions can build appropriate expertise in the use of the CitiVERSE to deliver public services and involve citizens in policymaking, but they also need public trust and buy-in. Building multi-stakeholder representation and participation is therefore a priority. As noted in subpoint 3.1.4, contextual factors can be more significant than technical characteristics and should be considered when planning citizen involvement in policymaking in the CitiVERSE. Jani Vallirinne (the project coordinator of Finland's national metaverse strategy, which was launched at the end of November 2023) has emphasised the importance of contextual factors. Vallirinne has highlighted the strong inclination towards mutual trust among people in Finland, and the fact that this trust extends to collaborative efforts between the government, companies and research organisations, as exemplified by the metaverse strategy aimed at achieving significant objectives (Grady & Vona, 2023). In this case, trust acts as a foundational element in encouraging citizens to embrace metaverse initiatives. Building and maintaining trust requires ongoing efforts by government agencies to prioritise security, reliability, transparency, user experience and privacy concerns in the delivery of digital services.

Finland's positive experience of public trust may not be replicable in all contexts. Several factors (e.g. cultural and socio-economic factors, and government transparency and accountability) contribute to variations in public trust levels and governments' experiences when using the technologies to deliver public services. Nevertheless, ensuring a sufficient degree of public trust is essential in order to encourage citizen participation (particularly when local governments have the possibility to implement potentially risky technologies such as brain recording).

Technology. The CitiVERSE is a digital representation of physical assets, processes and/or people within a geographically located community, which reflects and derives from cross-sectoral, historical and (near) real-time data from sensors, cameras and IoT devices to provide citizens with real-time insights into their urban environment. These data help decision-making on, for example, commuting, health and lifestyle (Alvarez Rodriguez et al., 2023). Big Tech players are at the forefront of building a centralised virtual worlds

infrastructure (some of them are using metaverse as their commercial name), but the use of AI, cryptocurrencies, blockchain, digital identity, data spaces, and other federated and open technologies is crucial to enabling decentralised control. This facilitates a broad spectrum of contributors and experiences, ultimately enhancing the dynamism and inclusivity of virtual worlds.

Decentralisation is a key concept in the development of the CitiVERSE. Various technologies play a crucial role in supporting this decentralisation. Blockchain technology challenges conventional governance models due to its decentralised operation and the lack of a central authority. The difficulty that the public sector faces lies in establishing precise regulatory frameworks and resolving disputes within this decentralised structure. Governments and regulatory bodies are currently grappling with the task of addressing the legal and compliance aspects associated with blockchain technology (De Filippi et al., 2022).

Automatisation of citizens' participation (as envisioned in the Specific CitiVERSE Scenario 3) poses potential risks that require attention. It is crucial to carefully consider both the tangible risks associated with automating participation and the subjective concerns related to this type of automation. For instance, individuals may rightly question whether this technology intrudes on their thoughts, if continuous monitoring becomes a reality, or if it jeopardises mental privacy and cognitive freedom (Rainey et al., 2020).

Interoperability and data portability. The CitiVERSE is expected to evolve from existing data platforms towards increasingly distributed systems. The main challenge for the CitiVERSE is therefore data interoperability and connectivity at interfaces between many different sectors. Lack of interoperability leads to a fragmented provision of services at the local level, accompanied by a lack of communication between different platforms, technologies and stakeholders. This in turn results in suboptimal services for the public (Alvarez Rodriguez et al., 2023). In addition to economic advantages and increased efficiency, interoperability can facilitate the development of a citizen-centred CitiVERSE and have a favourable impact on public values, including fostering trust between citizens and governments at different levels. Interoperability needs to be ensured at different levels, including (i) cross-border in order to support data exchange; (ii) cross-domain in order to promote more integrated public services; and (iii) between different levels of government in order to help commuters and inhabitants of border regions. The Interoperable Europe Act, which has been in force since 11 April 2024, is expected to pave the way towards an interoperable CitiVERSE, because it is intended to facilitate public-sector exchange of information across the EU and to accelerate the digital transformation of the public sector in the EU (EC, 2023c).

The first step towards interoperability and connectivity is to create an EU Smart Cities Data Space and ensure its wide adoption by relevant players. The EU Data Space for Smart Cities and Communities blueprint (DS4SSCC, n.d.) adopts these principles and refers to minimal interoperability mechanisms (MIMs Plus) to foster an EU digital market (Alvarez Rodriguez et al., 2023).

Digital identity. Many individuals on the internet lack their own digital identity and instead depend on major tech platforms like Facebook or Google for authentication and login. Within the CitiVERSE, individuals will need a unique digital identity in order to navigate across different platforms. A verifiable identity that is owned and managed by individuals and that protects personal data from data breaches and identity theft is a vital element of a decentralised CitiVERSE. The rise of blockchain technology has paved the way for the development of self-sovereign identity (SSI) systems. These innovative user-controlled identity management systems, which are empowered by DLT, eliminate the need for third-party custodians to oversee personal data (Stockburger et al., 2021). Discussions on SSI revolve around the idea that each citizen is the creator of their own identity, both in the digital realm and in real-life situations. Avatars, which represent individuals and their self-

sovereign identities, can give people more control over their cryptographically secure identities and provide opportunities for self-expression in ways that reflect personalities, preferences and interests.

The topic of digital identity within the CitiVERSE is currently under discussion. The EU digital identity wallet could be a solution, enabling users to establish trustworthy identification when needed and providing the flexibility to opt for alternative aliases or identities based on the context in which they are operating (Levallois-Barth, 2023). The initial projections on the 2030 digital targets set by the Commission for the Digital Decade Programme are that 100% of EU citizens will have a digital identity.

Safety. Promoting safety entails giving paramount importance to the welfare of individuals. It is crucial to guarantee the security of diverse digital systems, platforms and services that form the foundation of activities in the CitiVERSE. The objectives are to create a safe atmosphere for individuals and to foster trust between the platform and the digital citizens who interact with it. Ensuring safety in the CitiVERSE for citizens involves addressing various issues. One issue relates to malicious actors that exploit hardware and software vulnerabilities to compromise the confidentiality, integrity and accessibility of the data or functions of the CitiVERSE. Platforms adopted by the CitiVERSE also need to be cautious about weaknesses that hackers can target (e.g. centralised servers that handle key functions such as identity verification).

In general, it seems that most virtual world-related regulatory issues could be covered by the EU's existing digital regulation structure (including the GDPR, the Digital Markets Act, the Digital Services Act, and the regulations for AI, data and cybersecurity). Virtual worlds are an additional, if more immersive, channel for accessing data and services. Answering this question more deeply would require a thorough study of existing and forthcoming legislation and an evaluation of whether metaverse-specific amendments are needed.

Various standpoints could be taken when considering future legislation. For example, should virtual worlds be treated as products, delivery channels or second lives? The possible emergence of a class system within a metaverse should also be considered. The importance of transparency must be emphasised.

5.6 Possibilities for experimentation in the CitiVERSE

One of the IFRAG's tasks was to identify possible areas for experimentation and regulatory learning (EC: 2023c) in view of the potential use of virtual worlds in the public sector. Indeed, new technological developments usually create challenges and opportunities that may require regulatory adaptation or new interpretations of existing rules in order to ensure that these rules remain fit for purpose and achieve their intended objectives in the face of a new reality. As noted in Section 4, the EU's current regulatory framework implicitly or explicitly addresses many of the foreseeable implications of virtual world uses in the public sector. However, as we do not entirely know how virtual worlds will develop in the next 10 to 15 years, this is also the time to dig deeper into specific uses and to understand their operational consequences before deployment. This is where (regulatory) experimentation comes in. In particular, regulatory sandboxes (e.g. temporary experiments to test innovations in a controlled real-world environment under the supervision of a competent authority) allow innovators and regulators to learn from each other and to understand how an innovative idea can fit into the real world and its rules. We provide some suggestions for experimentation in the context of the CitiVERSE below. Similar approaches could be envisaged for other use cases (e.g. in health and education).

CitiVERSE: based on the three Specific CitiVERSE Scenarios described earlier in this report and following the Commission's 2024 recommendations to foster the use of generative AI in smart cities applications for the CitiVERSE, four examples of simulations of different policy settings using regulatory sandboxes are provided below. Such applications 'include simulation of possible settings such as the impact of changing traffic conditions on air quality, decarbonisation and congestion and more broadly on greening cities. It will also work on generative AI-based virtual reality applications to improve interaction with citizens, e.g. to actively consult them on planned urban changes' (p. 14).

- 1. **Traffic simulation:** create an environment for simulating various traffic settings using generative AI. This could involve adjusting parameters such as road layouts, traffic light timings and vehicle density to observe their impact on factors like air quality, congestion and decarbonisation.
- 2. **Air quality:** develop a sandbox specifically focused on air quality simulation. Use generative AI algorithms to model different pollution sources and atmospheric conditions. By adjusting variables like traffic patterns, industrial emissions and weather conditions, one can observe how changes affect air quality levels in different areas of a city.

Implications for policy: after conducting simulations using the sandboxing activities for traffic simulation and air quality, different settings are identified that can provide insights into the impact of tested factors and indications for actionable steps for governmental or public sector action. Examples may include:

Transportation policies	Urban planning regulations	Environmental regulations	Climate action plans
Implement measures such as incentivising public transportation, promoting electric vehicle adoption and implementing congestion pricing to reduce traffic congestion and emissions.	Enforce regulations for sustainable urban development, including zoning laws that prioritise mixed-use developments and pedestrian-friendly infrastructure.	Strengthen regulations on industrial emissions and pollution sources to improve air quality.	Integrate findings from the simulations into broader climate action plans to achieve decarbonisation targets.

- 3. **Data space integration:** integrate sandbox environments with relevant data spaces, such as the European Data Space for Smart Communities. This integration enables access to real-time data on energy consumption, mobility patterns and environmental indicators, thus potentially enhancing the accuracy and relevance of simulations.

Implications for regulation: integrating sandbox environments with the European Data Space for Smart Communities can be a significant advance that can enhance the accuracy and relevance of simulations. However, it also raises important considerations regarding data governance privacy and regulatory perspectives. We present two here:

Data governance and privacy	Data altruism and consent	Regulatory perspective
Robust data governance frameworks are necessary to ensure data privacy, security and ethical use when integrating real-time data from data spaces into simulation environments. This involves implementing measures such as anonymisation techniques, data encryption, access controls and compliance with data protection regulations such as the GDPR.	When real data (including personal data) are used, it can be critical to promote principles of data altruism and obtain appropriate consent from data subjects. Data altruism involves individuals voluntarily contributing their data for the common good, with full transparency and control over how their data are used. Establishing mechanisms for obtaining informed consent and empowering individuals to manage their data-sharing preferences is crucial.	The integration of sandbox environments with data spaces implies assessing whether current regulations adequately address the challenges and opportunities presented by such integration and identifying areas where regulatory updates or new frameworks may be necessary.

4. **Virtual reality interaction:** develop a virtual reality sandbox for citizens to interact with urban simulations and provide feedback on planned changes. Incorporate generative AI-based virtual reality applications that allow citizens to visualise proposed urban development options and explore different settings. This sandbox can facilitate public engagement with policymakers and can be used to conduct behavioural experiments to observe, measure and analyse various aspects of interaction (including cognitive processes, emotional responses and social interactions).

Implications for policy: by exposing simulations to people for their reactions and engaging them in dialogue, policymakers can gather valuable feedback and insights in order to refine proposed urban developments. However, this collaborative approach to regulatory learning and policymaking raises important considerations regarding the incorporation of policy options and potential regulatory implications.

Collaborative policy formulation	Regulatory implications
The interactive nature of the VR sandbox can facilitate collaborative policy formulation (e.g. policy prototyping) by fostering dialogue and engagement between citizens and policymakers. This participatory approach can enhance the legitimacy and effectiveness of policy decisions, leading to greater societal acceptance and support.	Regulatory implications may need to be addressed. Depending on the jurisdiction and the type of simulated settings, policymakers may need to consider whether existing legislation adequately accommodates such innovative approaches or regulatory exemptions or adjustments are necessary.

Through the implementation of these strategies, public buyers can build a collaborative ecosystem that encourages the continuous exchange of knowledge and innovation, driving forward the development and implementation of digital services in the EU.

6 Discussion of emerging issues

By diving into the specific case of the CitiVERSE, Section 5 illustrates through concrete applications some of the elements (e.g. scenarios, enablers, relevant stakeholders, risks and opportunities) introduced at the beginning of this report. This makes it possible to single out the most pressing issues for the attention of policymakers. Even in the face of current uncertainty on the future set-up of virtual worlds, it is certain that these issues will need addressing, particularly when the public sector is involved. Indeed, while virtual worlds are at the forefront of innovative opportunities, the cross-cutting nature of the issues discussed below will have to be addressed in order to preserve EU values (see also Council of Europe: 2023).

6.1 Cross-cutting issues that might compromise EU values

The following issues will arise from the functioning of any virtual worlds.

6.1.1 Anti-discrimination, mental, and physical safety

The immediate implementation of virtual worlds has **great potential to exacerbate existing social inequalities and mental health issues**. Indeed, the Commission's White Paper on Ethics of Artificial Intelligence asserts that algorithms can perpetuate and even stimulate racial bias. Low levels of critical digital literacy, which are largely due to the digital divide and systematic racism, are particularly harmful for those with low digital literacy skills, especially historically marginalised communities. Virtual worlds will, for example, disproportionately monitor racial minorities if they use biased data sets and conventional engineers who lack the social and environmental context to train the algorithms to ensure a safe and inclusive virtual world. Social media platforms have been shown to exacerbate mental health issues and increase the level of anxiety and depression among their users. There is a link between social media addiction, depression and addictive algorithms. Users of 2D social media (e.g. before virtual worlds) are already suffering from severe mental health issues because of their addictive algorithms. It is possible that avatar-based social media that integrate health, education and other activities in a virtual 3D world would use more addictive algorithms and increase mental health risks for their users.

A virtual world is primarily a digital environment, but there may be instances where physical safety concerns arise. Examples include issues related to in-person meetings arranged through virtual worlds; and the potential for physical harm resulting from VR experiences. In the case of in-person meetings within virtual worlds, questions may arise concerning the security and privacy of participants, as well as the potential for miscommunication or misunderstandings in a virtual setting. Ensuring the safety and well-being of users engaged in such interactions is becoming a critical aspect of the development of virtual worlds. In addition, virtual worlds could amplify issues related to online harassment, bullying and trolling. The immersive and interactive nature of virtual worlds may intensify the impact of such activities on individuals. Ensuring that measures are in place to address and mitigate these issues (e.g. effective moderation systems, community guidelines and reporting mechanisms) will be important in order to maintain a safe, secure and inclusive virtual world environment.

6.1.2 Data protection

People can participate in virtual worlds (including for the delivery of public services) through avatars, using special equipment such as VR headsets or similar devices that enable an immersive experience. This entails the collection of massive amounts of data (including

biometric data and data on the emotional and physiological responses of users) that qualify as sensitive personal data under GDPR and thus require special attention and explicit user consent for each purpose for which data are used. However, researchers are trying to find ways to make the use of enabling devices privacy-safe and GDPR-compliant without overly compromising the use of such devices.

Issues related to data protection

Blurred roles: identifying responsibilities and liabilities is difficult due to the multitude of entities present in virtual worlds. For instance, it might be **difficult to differentiate between data controllers and processors**. It will be difficult to determine who does what for whom. This raises the **issue of collecting user consent** and the obligation to display privacy notices (i.e. should it be done for each entity in the metaverse individually or for a particular virtual world as a whole?). Each specific purpose requires explicit consent. Moreover, users' data will be gathered more widely in virtual worlds, for example, if they are there to attend a concert or to participate in an auction. The collection of data will be involuntary and continuous, so consent will be impossible to obtain. Furthermore, immersion in virtual worlds requires integration of access points with services' consent, thus considerably reducing users' ability to avoid data collection. Protecting private virtual spaces from commercial and state interests raises the question of the confidentiality of personal correspondence in virtual worlds. The metaverse is likely to provide access points to digital content in the future, so opting out will not be feasible. It will be necessary to address the storage, handling and safeguarding of the data in virtual worlds; and responsibility for data theft and misuse.

Direct marketing: users will be offered product selection based on their behaviour and reactions, so direct marketing based on geolocation and emotional response will arise in virtual worlds. The **GDPR requires users to give their consent for sharing (selling) their data with third parties**. It is **unclear how to maintain this requirement in virtual worlds** where subliminal advertising may be increasingly effective. Eye-trackers can also give companies data that can be used to target advertising with extreme precision. The GDPR requires special protection for the personal data of vulnerable groups, particularly children. Effective age verification and measures to prevent children from providing personal data will therefore be required.

Intrusive profiling: access to sensitive data, such as emotional reactions, could lead to intrusive profiling that could result in harm (e.g. loss of control over one's life and decisions or voter manipulation), particularly for vulnerable groups. Governments have access to data from virtual worlds, so surveillance could also increase as Big Tech companies encourage more people to spend more time online.

Virtual workplace: employers can use virtual world-enabled devices to monitor their employees in real time. Perceptual experiences could therefore replace reflexive decision-making, leading to biased automated decision-making and inequalities in hiring, performance evaluation and training.

6.1.3 Liability

It is possible to engage in a wide range of illegal and harmful behaviours and practices in virtual worlds. The question is how to prevent or control this in virtual worlds, whose boundaries are still largely unknown. Virtual worlds pose many issues when it comes to addressing liabilities; combating harmful and illegal practices; and protecting intellectual property rights.

Issues related to liability

Illegal and harmful content online: content moderation will be challenged by AR and VR. Examples include verbal harassment and hate speech in virtual spaces; inappropriate actions by avatars simulated as sexual harassment and assault; pornographic content modelled on avatars; and misinformation or defamatory content generated with AR. Users might violate civil or criminal laws as they interact with their avatars. Meta's VR social media platform has already documented cases of women being harassed. These incidents happen in a virtual world, but they can still feel very 'real' and 'violating' to the victim. Virtual worlds could also become fertile ground for spreading disinformation and extremist ideologies (e.g. the resurrection of Osama Bin Laden in a virtual world). AI (including machine-learning algorithms and deep-learning architectures) will probably be central to virtual worlds. Those technologies could increase the ability of companies active in virtual worlds to track and monitor their users and customers in real time and to expand the negative impacts that some social media have shown in recent years.

Advertising practices: immersive marketing is taking off. One study has warned of consumer manipulation, but the impact of advertising practices in virtual worlds on consumers is unclear, given the psychological effects of immersive technology.

Protection of intellectual property rights (IPR): experts advice that it is challenging to enforce IPR in virtual worlds. Content in virtual worlds may be distributed and replicated across decentralised networks based on Web 3.0 and blockchain-based platforms. It is therefore more difficult to identify the provider that can take down infringing content. Infringers may be able to exploit issues with applicable law and jurisdiction. Unauthorised use of registered trademarks in virtual worlds is also a problem for popular brands.

6.1.4 Enforcement

The expansion of the internet and the resulting transfer of human activity to the cyberspace has created a clash between the borderless nature of cyberspace and law enforcement, which is strictly limited by state borders. Virtual worlds will increase the ensuing difficulties and add complexity to an already complicated situation.

Issues related to territoriality in cyberspace

States may define criminal activity and prescribe punishments even for activities that do not take place within their territory (**jurisdiction to prescribe**). Criminal liability therefore does not have to be linked with the territory of the state that prosecutes it. The link can be created, for instance, by the fact that the victim of the act in question was a citizen of that state or by the fact that the act infringed that state's interests.

However, the enforcement of those sanctions or, more broadly, the enforcement of state powers (including administrative penalties) is limited to the territory within the state's borders. It is a long-accepted principle of international law that states may use enforcement measures only on their territory and cannot act beyond their borders, because they would thus violate other states' sovereignty (**jurisdiction to enforce**). In other words, police officers cannot perform and judges cannot authorise a search of a house or an arrest of a person on the soil of a different country, unless there is a treaty between those countries that would permit them to do so. Such agreements have been rather limited to date. One example of such an agreement is Article 32 of the Cybercrime Convention (cross-border access to publicly available stored computer data). Another article is Article 41 of the Convention implementing the Schengen Agreement (continuation of a hot pursuit in another country). Many international conventions and EU legislative acts provide rules of cooperation in cross-border cases, but they always require the active participation of the state on whose territory an enforcement measure is to be undertaken.

Cyberspace presents a particular difficulty in this respect because, strictly speaking, even consulting a server located in another state by a law enforcement authority could be considered as a violation of that other state's sovereignty. Such limitations significantly hamper law enforcement capacities and effectiveness. The increased use of cloud computing – where the location of the data may be virtually impossible to determine or changes too rapidly – raises this difficulty to another level. Many legislative initiatives at EU and international level are therefore proposing solutions that would move away from traditionally construed territoriality. One example of such initiatives is the recently adopted E-evidence Regulation (Regulation (EU) 2023/1543).

Virtual worlds with different services operating in different countries and with servers on the territory of different states and data potentially circulating between them will yet again increase difficulties in this respect. It is therefore necessary to examine whether the legal instruments conceived to address the conflicts between the principle of territoriality and the nature of cyberspace include virtual worlds and are adapted to their nature. This is very important not only in order to ensure law enforcement objectives (such as effective combating of crime) but also for individuals. Practice shows that, where legal issues are an obstacle, law enforcement may ask digital companies to cooperate voluntarily. The fact that such cooperation is not compulsory may not secure sufficient protection for the persons concerned.

6.2 Should the EU go further and regulate virtual worlds?

EU policymakers should for the time being **focus on enforcing and monitoring the application of the EU's existing regulations** (such as the DMA, the DSA and the AI Act) before attempting anything like a 'Virtual Worlds Act'. Updating existing regulations will be time-consuming and may lead to overregulation. If a need to regulate emerges, policymakers should initially **aim for a 'minimum viable product' regulation** specific to virtual worlds. The legislation could be enhanced in response to new challenges later, as virtual worlds develop further.

The EU should prioritise innovation – through greater investment in relevant research and development – as it enters the domain of virtual worlds. This would ensure that the EU remains competitive in this emerging and promising field – while also addressing the societal and ethical implications of the technologies enabling virtual worlds. Indeed, the EU is currently lagging behind in the key digital technologies and breakthrough services. US and Asian entities are in the lead. The EU should therefore strive to promote developments critical to the success of a 'public option' for virtual worlds (for example, in terms of connectivity, interoperability, accessibility, adoption, and development of the necessary technologies and innovative services). Investment should focus on improving the overall environment, to make it more conducive to innovation and provide a solid basis for stakeholders to develop and plug into.

Virtual world environments are an emerging field. It may therefore be misguided to impose strict rules on technologies and services that are not yet well-understood; are still conceptually developing; or are not even adequately tested in EU markets. Against that, the EU should not wait too long to introduce relevant regulation, because a wait-and-see approach may raise a range of threats of another kind, allowing new and unforeseen concepts (that may have serious flaws and risks) to irreversibly take over the market and bring unwanted effects – before regulators can react meaningfully. Regulators should carefully and continuously monitor new developments so that they can promptly update the regulatory framework.

Regulatory questions particularly relevant to the CitiVERSE

Is new legislation needed to deal with the scenarios outlined above? If so, which legislation?

The recommendations put forward in this section are also largely applicable in the context of the CitiVERSE. Existing legislation can apply to virtual worlds to a large extent, but there may be a need to introduce adjustments that are specifically tailored to emerging issues and opportunities presented by these environments. Some additional critical conditions are therefore proposed here.

In relation to the CitiVERSE, the protection of citizens will require new legislation. Insufficient legal safeguards are considered as one of the implications of today's rapid expansion of immersive technology. The risks presented to individuals and society by 'biometric psychography' (Heller, 2020) require close attention by the legislator. 'Biometric psychography' is 'uniquely suited to a medium like VR that must track the user's eye positioning and locomotion to function and to a new industry that is looking for ways to make VR into a popular and profitable enterprise. There are currently no strong legal safeguards on the use, gathering, and storage of this type of information as it is not readily covered under existing biometrics law' (Heller, 2020, p. 4). If one imagines using an appealing visualisation: in a VR experience, human emotional response can be analysed and tracked (for example, eye pupil dilation can indicate how interested and excited a person feels at seeing a particular visualisation). Threats to data privacy include loss of control over personal data, concerns over data privacy breaches and intrusive profiling. Data collection in the CitiVERSE is claimed to be involuntary and continuous, making consent almost impossible and raising privacy concerns.

Randomly generated personal identities (deepfake) also need to be protected. In particular, the automatised of citizens' participation carries certain risks that need to be addressed. More legal

safeguards are needed to protect humans from the gathering and use of biological and brain-derived data. The EU's GDPR does not cover the privacy implications of technologies such as brain recording and has been considered insufficient to regulate privacy issues in the metaverse.⁵ For example, the metaverse (as promoted by Meta) has no boundaries and it is unclear how the GDPR's provisions on data transfer and processing outside the EU can be applied. The application of the GDPR depends on where the subject is located when their data are processed. When an avatar's data are being processed, it can be unclear whether the location is determined by the person operating the avatar – or by the avatar itself (Dwivedi et al., 2022). It is difficult to determine the jurisdiction of the avatar's location in the latter case (Lau, 2022).

The Big Techs have already established some safeguards for the protection of individuals in the metaverse. Examples include having 4 ft (1.22 m) personal space boundaries; and reinforcing serious infringement or 'stalker' cases with IP bans. In France, digital content and protection of citizens is provided by the Loi pour la confiance dans l'économie numérique, which makes the digital creator / content provider legally responsible for their output in order to ensure a safe environment.

Legislators should pay attention to issues such as the claim that data collection will be involuntary and continuous, making collection of consent impossible. To ensure that people's rights are protected, the processes governing informed consent around data processing may need to be revisited (Lau, 2022). Special attention should be paid to vulnerable people, such as minors, persons with diminished mental capacity, and those who are educationally or economically disadvantaged.

Are there regulatory loopholes to be considered?

Citizen information from existing digital and social platforms can be used in a virtual world or digital twin without their knowledge. Citizens are frequently unaware of what these platforms do or what consent they have given. For large CitiVERSE projects, it is necessary to inform citizens on how their data are used so that they can provide informed consent. There are issues associated with GDPR rules regarding the use of biometric data for avatars or physical demonstrations.

Other potential loopholes can be the Know Your Customer (KYC) verification services for financial transactions. These payments or interactions are likely to be made by digital or crypto currency, wallets and transactions, which require safeguards to validate the identity and legal status of users and to make it possible to provide to government revenue bodies and security agencies with the information they require. These regulations will decrease fraud and scams and thereby increase citizen engagement.

EU fintech and consumer protection regulatory frameworks may need to be revised in order to better align them with virtual worlds. This may require alternative approaches to anti-money laundering (AML) measures and digital identity, etc.

6.3 Could regulating virtual worlds hinder innovation? If so, what kind?

Regulating virtual worlds beyond a 'minimum viable product' regulation would currently be premature, but it is useful to anticipate some relevant considerations for policymakers, should the EU decide to legislate on virtual worlds in the future. Protecting EU values and policy objectives is paramount, but there are also several risks of stifling innovation in the process, as explained below.

Blocking use of the ecosystems by global tech companies

The EU is – unfortunately – not the leader in virtual worlds or any digital services. Innovation in this area is mainly carried out by US or Chinese Big Tech companies, and EU citizens and industries are dependent on them. If regulation limits the use of their latest technology in the EU, while it is allowed elsewhere in the world, the whole of the EU will suffer. The biggest danger is for EU SMEs that currently benefit from the global access these global companies can provide.

⁵ An overview of relevant literature on this topic is available [here](#).

Regulation in this area could open more interfaces in these tech companies' ecosystems, reduce unfair competitive positions and promote more competitive business models.

Regulating virtual worlds through interoperability requirements

Enforcing a certain degree of interoperability between virtual worlds (e.g. by setting standards on new technological interfaces or data structures associated with immersive technologies) can **support rather than stifle innovation**. Standards and interoperability prevent the formation of walled gardens, thereby supporting competition and ultimately driving innovation in the market for virtual worlds. The enforcement of a certain degree of interoperability is not at the heart of this question, but it would ensure that governments can contribute to and leverage virtual worlds technologies on their own terms, and could possibly enhance citizen's user experience by reducing frictions.

However, overly burdensome standards and interoperability requirements may also hinder innovation, particularly when the processes for defining, meeting and updating standards and requirements are slow-moving, administratively cumbersome or highly uncertain. Standards or interoperability requirements should therefore be set at a low level, where their benefits to innovation outweigh their costs. This can be achieved by setting requirements in close consultation with industry stakeholders and non-governmental standards organisations.

Blocking use of innovative technology and overprotecting citizens

Safety and accessibility requirements involve a similar trade-off to that for interoperability requirements. By effectively increasing the total addressable market for virtual worlds solutions, accessibility requirements (e.g. the ones stipulating access for users with disabilities or limited digital literacy) can support competition and innovation. By increasing the quality of virtual worlds experiences and mitigating potential negative externalities associated with the provision or use of metaverse solutions, safety requirements can ensure that the societal value generated by metaverse innovations trumps their societal costs. However, overly burdensome requirements can hinder innovative activity.

Sometimes, regulations need updates to ensure that intended objectives are achieved. New technological developments may offer more efficient solutions. For instance, it should be evaluated whether the current practice of websites asking consent for enabling cookies is effective for the objective sought. Perhaps other forms of consent that are adaptable to new environments such as virtual worlds are conceivable.

Considering the European Digital Rights and Principles and the centrality of citizen safety and equity to the EU mandate, safety and accessibility requirements should be set at a higher level than interoperability requirements, and potentially at a level where their costs to innovation slightly outweigh their benefits.

Selecting technology that quickly becomes obsolete

Regulation should not select one technology over another. Virtual worlds are still developing quickly and fixing too early around one solution could impede the EU's development in this area.

These issues notwithstanding, public services (especially public procurement of technologies for them) can be a great driver of innovation, and even greater than funding innovation in this area. The budgets for IT-investments, their operations and deployment

are huge and selecting right solutions is essential. Possibilities for experimentation (e.g. using regulatory sandboxes, testbeds and living labs) should be considered (Kert et al., 2022).

Despite the continuous development of the Digital Single Market, digital solutions for public services are highly fragmented. Countries, regions, cities and even schools or hospitals are choosing separate and independent solutions. This not only decreases the incentive for private companies to invest in the market, but also further fragments the resulting infrastructure, making it more costly to manage and even more challenging to innovate with.

Public procurement can be a vital tool to stimulate innovation in the digital services sector. Public procurement policies can significantly influence the pace of innovation in the EU, where there is a combination of diverse markets and technological capabilities. The following are some strategies and best practices that can be used to accelerate innovation through public procurement.

	Example	Best practice
Agile procurement	The UK government's digital service has adopted agile procurement methods which allow iterative development and delivery, encouraging innovation and responsiveness.	Implementing agile procurement processes that encourage continuous collaboration between suppliers and government agencies.
Pre-commercial procurement (PCP)	Horizon 2020 (the EU's research and innovation framework programme) has facilitated pre-commercial procurement in order to foster innovation by allowing public sector bodies to purchase research and development services.	Encourage pre-commercial procurement in order to stimulate the development of innovative solutions by allowing companies to co-develop solutions without the constraints of traditional procurement.
Innovation partnerships	The city of Barcelona has initiated innovation partnerships in which it works with various tech companies and start-ups to develop smart city solutions.	Establish partnerships between public sector bodies and private companies to jointly develop innovative solutions, fostering a collaborative approach to problem-solving.
Open standards and interoperability	The European Interoperability Framework guides the public administrations in providing digital services that facilitate interoperability and the use of open standards.	Encourage the development and adoption of open standards to foster interoperability, which can spur innovation by avoiding vendor lock-in and facilitating data exchange.
Public procurement for green and digital transformation	The Commission's strategy on leveraging public procurement for a greener and more digital Europe, fostering innovation in environmental and digital technologies.	Integrate objectives of digital and green transformation into public procurement strategies in order to stimulate innovation in these sectors.
Crowdsourcing and open innovation	The city of Paris has initiated participatory budgeting processes, in which citizens can propose and vote on projects, fostering innovation at the grassroots level.	Implement crowdsourcing strategies in public procurement in order to foster open innovation, allowing a range of ideas and solutions to be explored.
Capacity-building and skills development	The EU's Digital Europe Programme focuses on enhancing digital skills across the workforce, fostering innovation through capacity-building.	Develop programmes to enhance digital skills and capabilities within the public sector, fostering a culture of innovation and readiness to adopt new technologies.
Transparency and accessibility	The EU's Tenders Electronic Daily provides free access to public procurement notices, fostering transparency and accessibility.	Promote transparency and accessibility in public procurement processes to foster competition and encourage participation by a broader

Sharing best practices and collaborative learning

The European Assistance for Innovation Procurement initiative supports public procurers across the EU in developing their innovation procurement projects by sharing best practices and case studies, and by providing free assistance.

range of suppliers, including SMEs and start-ups.

Establish forums, workshops and digital platforms where public procurement organisations can share their experiences, learn about successful case studies and adapt innovative technologies and methodologies.

Create communities of practice where procurement professionals can engage in collaborative learning can foster innovation.

Develop centralised repositories where procurement organisations can access a range of resources, including templates, guides and tools that are aligned with the latest industry standards and technologies.

Facilitate cross-border collaborations to share insights and strategies that have been effective in different regions, thereby encouraging a harmonised approach to innovative procurement across the EU.

Encourage mentorship programmes in which experienced procurement organisations guide and support less experienced organisations, thereby fostering a culture of cooperation and mutual growth.

Establish awards or recognition programmes to acknowledge and incentivise innovation in public procurement, thereby encouraging organisations to adopt best practices and innovative approaches.

Balancing innovation and regulation

As noted earlier, the scaling-up of virtual worlds could concentrate the power of Big Tech still further, especially because of their role in providing infrastructures and data. Such a concentration of power would determine the vision underpinning the creation and governance of virtual worlds. It might prevent any open and decentralised ‘community form’ that would encourage participation, collaboration and transparency. It is therefore becoming crucial to define and implement EU standards for virtual world platforms in order to foster interoperability. However, it is also important to strike a balance in order to avoid stifling innovation with overly burdensome regulations. Regulations can act as stepping stones and provide a direction for where technology can end up in a way that is fair and consistent with EU principles.

Fair regulatory and legal protection plays a central role in fostering a healthy and competitive entrepreneurial environment, especially in the context of emerging technologies and the influence of Big Tech. By establishing a regulatory framework that addresses aspects such as data privacy, intellectual property protection and anticompetitive practices, policymakers can create an environment in which entrepreneurship is protected, innovation is encouraged and citizens can benefit from a diverse and competitive market.

7 Conclusions and recommendations

Virtual worlds provide many untapped opportunities to enhance the development and delivery of better services. However, it is crucial to exercise caution when using virtual worlds models in the public sector – particularly for some health and law enforcement applications that involve sensitive data. Before applying virtual worlds environments to public administration, the following questions should be answered:

1. Where is the application of the virtual worlds model most relevant?
2. What are the most important sectors that would benefit from it?
3. Which users will ultimately benefit from such digital transformation?

It is equally important to consider some **fundamental requirements** when assessing any technology innovation push into the public administration. Innovative technology, services and models need to be:

- **relevant** (to actual needs);
- **useful** (usefulness is about defining the real value of virtual worlds – providing more value to users than the existing alternatives (e.g. in the health sector));
- **necessary** (where no other valid alternatives exist – e.g. the natural environment);
- **wanted** (never imposed on the final users);
- **accepted** (among equally valid alternatives);
- **suited to / preferred by** the target contexts/users (not disruptive of underpinning values and needs, such as education – cognitive development);
- **attractive** (i.e. appealing and user-friendly – not leading to a dystopian approach);
- fostering and **enriching/empowering** (not a hiding place from reality);
- **accountable** and **assessable** (governance should be aligned with the public interest);
- **respectful** of the public sector mandate, and its underpinning principles and social values (institutions should monitor responsibilities and impacts).

To meet these fundamental requirements, proposed virtual worlds models must demonstrate tangible benefits for users (whether they are public administrations, citizens or businesses) by comparison with existing solutions. The balance between benefits and risks must be carefully evaluated and respected. Thorough consideration of ethical, legal and human rights implications must precede any decision-making in this direction.

7.1 IFRAG conclusions

Experience shows that there is no one-size-fits-all solution. Nevertheless, a careful examination of contexts, regulatory frameworks and essential principles can yield valuable insights that may influence the adoption of virtual worlds technologies and models. Such insights can also inform the development of proactive regulations, thereby mitigating some of the risks associated with the rapid integration of these systems and models into the ongoing digital transformation of our society.

The way public services can be deployed through virtual worlds can vary greatly, depending on the actual development and governance of the technology and the resulting ecosystem, and particularly on the areas of application and modes of use by the target audience. Many instances of virtual worlds already exist (as highlighted in Section 2), but the IFRAG foresees a coming wave of virtual world instances aimed at solving sector-specific

challenges (e.g. in healthcare, education and other relevant sectors). Among citizen-oriented services, the public sector might have a particularly strong role to play in urban services (e.g. the CitiVERSE) and mobility. Furthermore, for public services that cannot be provided by private entities, a scenario for delivery by decentralised providers and made by open and community-owned entities is preferable. The role of public institutions in the governance of virtual worlds can range from an extremely limited one, in which private corporations are the main actors for virtual world development and administration (Scenario 2), to one where public institutions steer and shape virtual realities (Scenario 1). Between those two extremes lies Scenario 3, where public and private actors share ownership of the necessary infrastructure and applications for virtual worlds. All three scenarios bring distinct benefits and challenges. Scenario 1 raises governance challenges, could result in a less optimal user experience and may lead to an overly fragmented landscape of virtual worlds; but it could result in virtual worlds that are inclusive and fair. Scenario 1 would promote democratic user participation. Scenario 2 raises a number of issues – from exacerbating existing power imbalances in the tech world and lack of competition, to creating risks for public administrations and the provision of public services, data governance issues, and accountability and explainability challenges. It could also lead to faster innovation and better user experience. Scenario 3 can take many forms, depending on how ownership is divided between private and public players, but could potentially offer the best of both worlds in the right balance, with companies contributing proprietary solutions to a larger and more open ecosystem that promotes cross-solution and cross-sector interoperability and collaboration. To achieve the best possible balance, the EU and its Member States should be given meaningful regulatory capacity over the sector and develop adequate technical know-how.

In a nutshell, the following **key conclusions** can be drawn from the IFRAG's work.

- Virtual worlds may provide important opportunities and quality-of-life improvements for EU citizens and industry, mainly by offering more opportunities to access and interface with existing services, thus fostering inclusiveness.
- This area complements existing digital platforms and ecosystems. Many existing technologies serve as enablers for virtual worlds.
- Issues concerning legislation, innovation and interoperability are similar to those encountered in established domains, but the stakes are arguably higher due to the potential for user harm stemming from highly immersive experiences.
- As a concrete example, the integration of virtual worlds and the CitiVERSE can enhance the delivery of public services. This trend is already evident in fields such as education and healthcare. However, harnessing related opportunities requires advances in technological maturity, the lawful application of innovative solutions and user acceptance.
- Technological maturity will develop gradually, bolstered by investments in the sector. However, critical enablers (e.g. affordable and high-quality headsets) are still a few years away from widespread adoption.
- Investment mostly comes from outside the EU and is primarily led by major technology corporations. Their dominance in this area presents both opportunities and threats for the EU, including compliance with ethics and human rights protection, thereby also impacting users' acceptance.
- Corporation-based ecosystems will probably drive the development and consumption of most non-public services. This offers advantages such as attractiveness to citizens and business opportunities for EU-based industries (including SMEs), but it also poses risks

due to conflicts between ecosystem rules and EU values, as well as the outflow of commercial value from the EU.

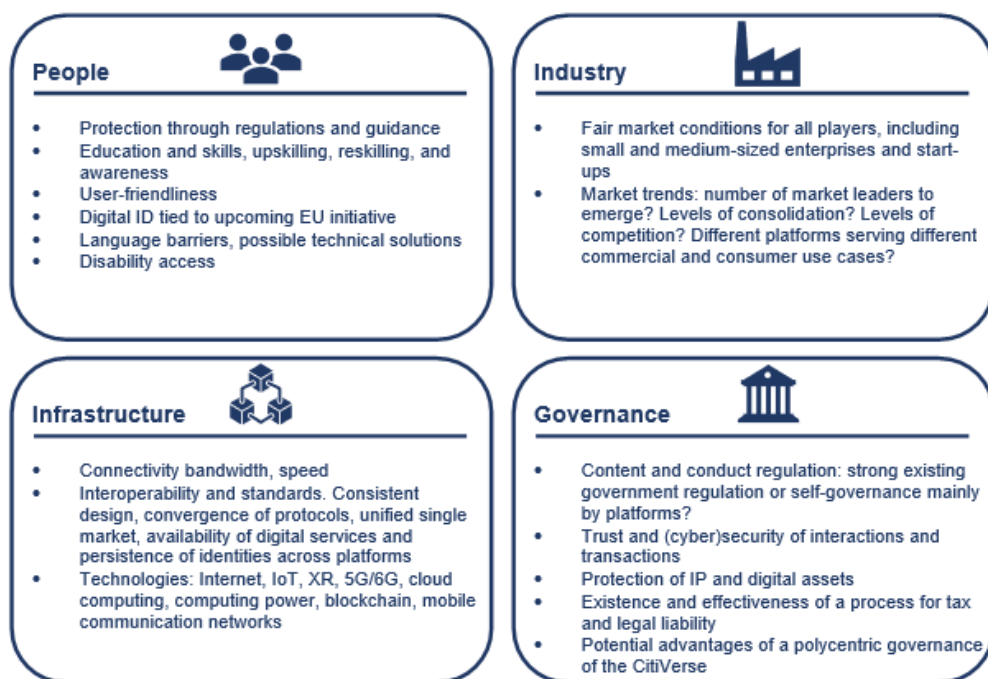
- Existing regulations (e.g. the Digital Markets Act (DMA) and the Digital Services Act (DSA)) largely cover the issues encountered in virtual worlds. Specific amendments may be necessary for emerging technologies like biometrics, but these can be deferred until they have matured further.
- Various approaches exist for public sector organisations in the EU to foster the deployment of virtual worlds. Many applications are still at an early stage, but governments should act as incubators for these services, with a view to achieving global leadership; optimal service provision for citizens; and the cultivation of new EU leaders in ‘GovTech’, public interest technology and related solutions.
- Initial experiments and careful reflection suggest that virtual worlds are currently being piloted in environments where clear benefits and utility exist, and where socio-economic and regulatory risks are relatively low. It is therefore evident that – due to the diversity of contexts in which public administrations operate across the EU (each with its own unique characteristics, opportunities, challenges and risks) – comprehensive evaluations and testing (e.g. through regulatory sandboxes) are needed before virtual worlds solutions can be deployed further.

7.2 Challenges and recommendations

The IFRAG recognises that **political, economic and societal elements are unavoidably intertwined** with any innovation project and related process – even those apparently centred primarily on technology and economic considerations. Virtual worlds should therefore not be exclusively oriented towards enhancing economic value but should also be oriented towards the preservation of individuals and their rights as **citizens**. If a community-based virtual world instance is finally deployed, efforts must therefore be made to deploy every virtual world-based public service to serve citizens as **human beings** in the first place, rather than as mere **consumers**.

On this basis and depending on the specific context and needs, it could be possible to apply a combination of decentralised and centralised elements to create a hybrid virtual world governance model. In the case of the CitiVERSE, a decentralised, technology-agnostic, open and user-centric governance is expected to benefit user empowerment, digital identity and future digital rights. By contrast, certain aspects (e.g. law enforcement and targeted policies) may be more effectively addressed by centralised governance structures. In the hybrid model, associated risks are better mitigated and both models’ strengths are also preserved. A balance therefore needs to be sought in each instance, based on the proportionality principle and by considering the needs and objectives of all relevant actors.

The key issues to be addressed for virtual world-supported public services – to meet actual needs while aligning with socio-economic-cultural dimensions – are less about technology *per se*; and rather about striking a power balance, establishing the right framework conditions and respecting fundamental prerequisites. Addressing these challenges requires the promotion of dialogue between stakeholders at all levels. In view of the above and the issues identified and discussed in Section 6, the IFRAG recommends that the EU and its Member States should focus on the following **challenges** in relation to virtual worlds and should take the suggested **dedicated actions** – applying **best practices** from related policy areas where applicable.



7.2.1 People

Challenges

- **Complexity challenge:** the unwanted impacts of virtual world-enabling technologies cannot be overcome by regulations alone – just as simple technical fixes on the margins alone cannot suffice. A more complex socio-technical response is probably required. The complexity of the issues raised by virtual worlds exceeds the current regulatory expertise and capacity of legislators and public authorities.
- **Digital rights and principles challenge:** eight values and principles for desirable and fair next generation virtual worlds were agreed in the large-scale citizens' panel organised by the Commission in the first half of 2023: freedom of choice; sustainability; human-centricity; health; education and literacy; safety and security; transparency; and inclusion. These can serve as a compass to guide the next steps in better controlling and safeguarding digital rights and principles.
- **Participatory innovation challenge:** consultation and participatory innovation will also be very valuable because they will probably lead to the inclusion of unheard or marginalised views and ideas that could make the innovation process more objective and robust and provide innovative solutions that are ahead of their time, and therefore unique and possibly more sustainable. In this context, authorities would do well to consider what types of cross-government and cross-sector organisations could support the dissemination of information related to virtual worlds and specifically to the CitiVERSE. Guiding principles could thus be established to shape the design of systems without stifling creativity and experimentation.

Recommendations

Ensuring the **societal acceptance and appreciation** of virtual worlds and their use by public sector organisations is key to their development and adoption. However, there is also a need to support an **adequate technical know-how and apply stringent regulatory capacity** in the tech sector in order to ensure users' safety and therefore trust. The IFrag therefore recommends the following courses of action.

Take a leadership role in the development and use of virtual worlds

Take a leadership role in the development and use of virtual worlds with all relevant stakeholders (including influential actors based outside the EU) that can help satisfy the critical features of a truly EU public virtual world, by proactively reaching out to them. Many influential non-EU actors will be corporations based in the United States or Asia (e.g. South Korea), well-advanced and well-equipped to provide virtual-world-enabling infrastructure. The EU should invite them into consultations in order to promote alignment with EU principles and values. For instance, the United States does not currently have a comprehensive ethical framework or law on virtual worlds, but it is home to intensive and extensive discussions on the topic of regulating this environment. EU governments will need to partner with those stakeholders and join forces (talent, infrastructure, computing power and data) to ensure a suitable virtual world environment that respects human rights and EU values; that is safe, cyber-secure, efficient, speedy, accessible, etc. (in short, gains the trust and interest of EU citizens); and satisfies all the critical factors of 'a truly virtual world'.

Best practice: the GDPR, AI and platforms (the DMA, the DSA and the AI Act).

Responsibility: the EU and Member States.

Provide capacity-building and skills development

Develop programmes to enhance virtual world-related digital skills and capabilities within the public sector, fostering a culture of innovation and readiness to adopt new technologies. Support the public sector in building internal capability and capacity so that public servants can procure, use, manage and especially evaluate the added value of undertaking initiatives related to virtual worlds. For example, a toolbox for designing public services in CitiVERSE virtual worlds could be developed to help public service managers, employees and other interested parties understand the objectives and related design process. Such a toolbox would combine resources for the selection of relevant technologies, assessment of needs and design of user experience (UX); derive policy and legal recommendations; and promote community engagement.

Best practice: the EU's Digital Europe Programme focuses on enhancing digital skills across the workforce, fostering innovation through capacity-building.

Responsibility: the EU and the Member States.

Foster crowdsourcing and open innovation

Implement crowdsourcing strategies in public procurement in order to identify the most attractive services for citizens.

Best practice: the city of Paris has initiated participatory budgeting processes, whereby citizens can propose and vote on projects, thus fostering innovation at the grassroots level.

Responsibility: national agencies for public procurement; technology and innovation agencies; and local authorities.

Empower citizens through proactive information provision, education and awareness-raising

Information, education and awareness-raising to ensure citizens' empowerment and autonomy in the understanding and use of public services provided by virtual worlds models.

Best practice: a toolbox dedicated to public sector administrators, and resources for young people and prospective users, to foster understanding of and provide guidance on the development and use of trustworthy virtual worlds, as already proposed by the Commission in 2023. A Local Digital Twins (LDT) Toolbox is currently under development.

Responsibility: the EU, Member States, and regional and local authorities.

Challenges

- **Competition challenge:** the issues of industry and infrastructure are closely connected. As noted in subpoint 2.1.2, virtual worlds bring questions of competition to the foreground. The high costs involved in their development and scale-up (relating to aspects such as infrastructure, computational power and data) mean that there is a high risk of further empowering global technology giants that have such resources readily available.
- **Lock-in challenge:** this could in turn lead to an oligopolistic market structure where a relative lack of competition results in worse outcomes for users. It might also lead to increased switching costs between technologies, effectively making users dependent on a particular vendor's technology by making it incompatible with other infrastructure or applications.

Recommendations

To address the challenges outlined above, we recommend the following actions.

Encourage open standards on interoperability

Encourage the development and adoption of open standards to foster interoperability, which can spur innovation by avoiding vendor lock-in and facilitating data exchange. Many successful standards (e.g. GSM in the 1990s) were accelerated by the increase of public procurement.

Best practice: the European Interoperability Framework guides public administrations in providing digital services that facilitate interoperability and use of open standards. The European Digital ID, and the Finnish MyData-approach on user data ownership and transfer are other relevant examples.

Responsibility: the EU, Member States, standardisation bodies and stakeholders (in the broader sense).

Facilitate transparency and accessibility of purchasing

Promote transparency and accessibility in public procurement of virtual world infrastructures and applications in order to foster competition and encourage participation by a broader range of suppliers (including SMEs and start-ups). Encourage joint purchasing by multiple Member States to drive greater investment and a Digital Single Market.

Best practice: the EU's Tenders Electronic Daily provides free access to public procurement notices, fostering transparency and accessibility.

Responsibility: the EU and Member States.

Take a leadership role in the development and use of underlying enabling factors and features

The EU should take interoperability and standards as horizontal enabling factors. Interoperability grows organically when it is needed, irrespective of the specific sector. The public sector's adoption of technologies that underpin virtual worlds could drive the emergence of common protocols, including standards. Private platforms that aim to lock in their users do not have a natural incentive to use common protocols. However, once the public sector appears on the scene, they will need to adapt to such interoperability features and standards so that their hardware can work with the public sector. The public sector can therefore act as a catalyst for the organic development of cross-platform protocols. It is also important to facilitate collaborative innovation. Regulations should aim to facilitate collaboration between the main actors (e.g. start-ups, SMEs and tech giants) by enabling synergies that can drive innovation forward. The identification and empowerment of champions within actors' communities could support such efforts.

Best practice: the Interoperable Europe Act and related approaches such as the Interoperable Europe Academies.

Responsibility: the EU and Member States.

Challenges

- **Cost of deploying a virtual world instance challenge:** a large-scale virtual world is a cost-intensive platform, regardless of which stakeholder is responsible for deploying it. It is intensive in hardware acquisition; software development; data storage and processing; network infrastructure; and security and privacy measures.
- **Environmental sustainability and financial viability challenge:** achieving long-term financial viability is a significant challenge. The operational costs of running and maintaining virtual worlds (including hardware infrastructure, software development, content hosting and user support) need to be fully considered, as does the environmental impact in terms of energy requirements.

Recommendations

The IFRAG recommends addressing the identified challenges by implementing the following actions:

Increase public funding of virtual worlds

Investigate mechanisms for funding virtual worlds initiatives targeted at supporting the establishment and growth of citizen-run virtual worlds infrastructures and/or applications (e.g. in Horizon Europe and other relevant instruments). Initiate similar programmes in Member States through national and regional funding instruments and make them complement EU-related funding schemes.

Best practice: the CitiVERSE EDIC (see point 3.4) is a flagship initiative of the EU. This multi-country project will own and operate common infrastructures for digital twins of cities.

Responsibility: public funders at all levels of public administration need to act in a coordinated way in order to ensure the best use of public expenditure.

Enable pre-commercial procurement (PCP)

Encourage a more flexible PCP scheme to stimulate the development of innovative solutions by allowing companies to co-develop more relevant and better accepted solutions for service delivery through virtual worlds, without the constraints of traditional procurement processes.

Best practice: Horizon 2020, an EU research and innovation programme, has made it easier for PCP to foster innovation by allowing public sector bodies to purchase research and development services.

Responsibility: the EU and Member States.

Challenges

- **Risk mitigation challenge:** public services that use virtual worlds must consider the issues and policy implications described in this report. As already stated, both the education and health sectors as well as emergency services can be positively impacted by virtual worlds. However, it is important to note that public services in education and health typically manage sensitive personal data. In this context, data management becomes fundamental because public administrations should be solely responsible for the data they collect, in order to avoid unnecessary risks. Ensuring robust data protection measures, privacy safeguards and cybersecurity protocols is paramount.

- **Governance and community engagement challenge:** a centralised governance structure can be more effective in decision-making, implementing policies and enforcing the law; and can offer advantages such as efficiency and consistency. However, establishing participatory governance structures and community engagement mechanisms is crucial for a fair, just and lawful community-based virtual world. Ensuring inclusivity, transparency and accountability in decision-making processes can be challenging (particularly when multiple stakeholders and diverse community members are involved) but it is very necessary.
- **Content moderation challenge:** it is unclear to what extent EU rules on content moderation will apply to illegal or harmful content in virtual worlds. The scope of the AI Act includes the use of biometrics and subliminal, manipulative or exploitative techniques in a virtual world. Virtual reality is not specifically addressed in the DSA, the AI Act or the forthcoming liability framework for emerging digital technologies, and further amendments to EU law may be needed to keep users safe online. Scepticism remains about Big Tech's self-regulatory approach to content moderation in virtual worlds. Online platforms and law enforcement agencies should take further steps to identify and respond to dangerous or illicit content (e.g. strengthening protections against non-consensual sharing of intimate images and defamatory content) and ensure the application of liability laws to online intermediaries (taking AR/VR users and platforms into consideration). Another relevant open question is whether avatars need legal personality to be responsible for their actions in virtual worlds – or, at the very least, whether criteria need to be identified in order to distinguish between avatars and the real legal individuals operating them.
- **Open and decentralised virtual worlds challenge:** a decentralised virtual world model is emerging, which is controlled by users themselves via decentralised autonomous organisations in order to enable universal operation and interoperability. Users themselves can control their data and decide how it is shared in a decentralised virtual world model. This could address data protection issues that are difficult to resolve in more centralised scenarios. Several tensions exist between blockchain technology and data protection regulations. Some researchers recommend establishing regulatory guidance, codes of conduct and certification mechanisms for identification and transactions.
- **Advertising rules and intellectual property challenge:** it has been argued that advertising legislation needs to be revised in order to address its implications in virtual worlds. It is believed that the current rules governing video games will influence the regulatory framework for advertising in virtual worlds. A new French advertising guideline clarifies the rules for virtual universes. The current trademark laws seem to be applicable to virtual worlds, but some experts stress that it may be useful to include specific references to virtual worlds in the law. Several experts propose limiting emotion-driven advertising in order to restrict virtual product placement within virtual worlds and to improve transparency through regulations.

Recommendations

- Regulatory measures will be necessary (especially to foster ethics and human rights protection), but it is crucial not to overregulate and to craft legislation in a way that avoids hindering innovation. The IFrag therefore recommends the following courses of action.

Provide a flexible regulatory framework, including regulatory sandboxes

- The design, development and adoption of virtual worlds are very much related to context, time and framework conditions. The EU and its Member States should craft regulatory frameworks that are flexible and can adapt to the fast-paced evolution of technology and socio-economic-cultural changing needs, rather than set-in-stone and static ones that might hinder innovation and soon become obsolete. Regulatory sandboxes are a valuable tool for future-proof regulations in fast-evolving sectors. They could be used to 'test before investing' in virtual worlds models, technologies, service adoption and perception, and especially on the suitability and relevance of regulations, with a view to making better informed decisions based on mutual learning and validated approaches.
- In addition, 'CitiVERSE regulatory sandboxes' and other experiments (i.e. testbeds and living labs) can be used to test various regulatory frameworks and urban planning strategies in order to address pressing issues. For example, using IoT real data that power local digital twins to simulate and experiment with different scenarios could help set initial conditions for key parameters that influence urban flooding (e.g. spatial distribution of rainfall in urban areas and impervious surfaces), and then run and validate simulation models to understand the impact of specific events. This can help proactive decision-making and maintenance-planning processes.
- **Best practices:** the design of recent EU policies (e.g. the AI Act and the Interoperable Europe Act) focused on governance processes and organisational structures instead of on specific technologies. Moreover, the AI Act's use case and risk-based approach places the attention elsewhere from technical details, while addressing the critical aspects of protecting EU rights and values, as well as EU citizens and businesses.
- **Responsibility:** the EU, Member States, and regional and local authorities.

Share best practices and collaborative learning in procurement

- Establish forums, workshops and digital platforms where public procurement organisations can share their virtual world experiences; learn about successful case studies; and adapt innovative technologies, models and methodologies. Create communities of practice where procurement professionals can engage in collaborative learning that can foster innovation.
- **Best Practice:** the European Assistance for Innovation Procurement initiative supports public procurers across the EU in developing their innovation procurement projects by sharing best practices, case studies and providing free assistance.
- **Responsibility:** the EU, Member States and local authorities.

7.2.5 Recommendations on the CitiVERSE

In addition to the above, the following specific recommendations concern the CitiVERSE, mirroring an ongoing discussion about the development of a roadmap towards a pre-standardised EU CitiVERSE.

- **Strengthen confidence** in and the effectiveness of civic services by **fostering close collaboration** between local public authorities, urban planners and technology providers. The focus of this collaboration should be on determining how these technologies within virtual worlds contexts can best benefit citizens and evidence-based decision-making.
- Encourage **robust partnership models** between public entities, research institutions and private technology providers in order to drive innovation and tackle the unique challenges associated with public governance by implementing smart city and CitiVERSE projects.
- **Address CitiVERSE key challenges**, especially on the supply side (e.g. governance, policy issues, environmental considerations, economic factors and technical obstacles). The goal is to establish decentralised, technology-agnostic, trustworthy, secure, open, citizen-centric, sustainable, interoperable and accessible platforms for digital twins and CitiVERSE implementation, in full compliance with the EU's values and principles.
- Ensure **seamless technological integration and functionality**, so that the supply side should develop open specifications and protocols, which are essential for promoting interoperability between networks and

platforms; supporting user freedom; enabling digital ownership; facilitating cross-platform activities; and creating economic opportunities.

- Intensify efforts by standardisation organisations to systematically address primary needs and challenges on both the demand and supply sides. **Coordination between EU and international standardisation organisations** is crucial, especially if protocols and standards for specific technologies are lacking. This collaborative approach will ensure comprehensive coverage and promote a coherent framework for addressing the evolving technological landscape.

- Promote **co-creation** and **participatory approaches** and models, by supporting the engagement of diverse organisations and community groups in the design, development and delivery processes of innovative public services, through CitiVERSE-dedicated virtual worlds environments.

7.2.6 Recommendations for further research

It is highly advisable for a **human presence and monitoring to be an integral part of virtual worlds ecosystems in order to protect human rights and values, and improve risk mitigation**. The above recommendations provide a solid foundation that can help the EU reach this delicate balance between promoting innovation and ensuring its alignment with EU values and principles. Nevertheless, as virtual worlds develop, more research will be needed in order to provide an adequate evidence base for policymaking. In particular, future research should try to identify and understand how beneficiaries perceive services facilitated by virtual worlds; and then either change the approach or validate the underlying paradigms and principles that guide them. Responsibility for the implementation of the proposed actions lies (primarily) on the Member States and the actors of the different local innovation ecosystems, supported by EU-friendly regulations that foster their development.

Non-exhaustive list of research actions

- Further research is needed on the impact of the **principle of territoriality on law enforcement and the preservation of individuals' rights** in virtual worlds. EU-level legislation and international treaties should be examined in order to assess their suitability to virtual worlds in specific territorial contexts. It is possible that more suitable instruments could be designed in order to address virtual worlds features in such dedicated environments.
- The EU's current societal structures are complex, influenced by rapid technological advancements and characterised by constantly evolving dynamics and governance models. Predicting the exact **impacts of virtual worlds – how, by whom, when and where** they will manifest themselves – is challenging but such investigation is very necessary.
- Virtual worlds are likely to involve a complex blend of public and private governance models in which power games are critical drivers and therefore present a number of challenges and opportunities. This requires further research into **emerging dynamics** that include issues surrounding trust, privacy, data governance, conflicts of interest, control versus inclusion, efficiency, service delivery improvements, and the balance between centralisation and decentralisation of governance.
- **Critical sectors** such as health, law enforcement, employment and urban planning demand **prior testing and experimentation** in real-world settings – albeit within safe and controlled environments that are enabled by regulatory sandboxing approaches and involve relevant stakeholders. The necessary insights in these critical sectors could be further explored through future initiatives and services led by the Commission (e.g. the AI Office) in collaboration with relevant stakeholders.

The IFRAG concludes that only a careful examination of the diverse contexts; socio-economic implications; regulatory frameworks; and the essential needs, values and principles to be respected can provide valuable insights that may influence the design, development, acceptance and adoption of fair, inclusive, lawful and sustainable virtual worlds within public governance environments. Such insights can also inform the development of more relevant innovation-friendly regulations or adapt existing ones, thereby mitigating the risks associated with the rapid integration of these systems and models into the ongoing digital transformation of our society, while also seizing the opportunities offered by emerging digital technologies and models that will shape our future ways of living in the real world.

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Annex 1: List of EU initiatives and legislation

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Annex 2: Virtual worlds definition, characteristics, and related concepts

Definition of virtual worlds

As noted in Section 1.2 of the report, the authors further elaborate on the definition of virtual worlds here, to better clarify the concepts and the characteristics that they have taken into consideration to fulfil their mandate for the IFRAG.

Revised definition proposal:

***Virtual worlds** are immersive, persistent and shared environments, provided by different interfaces and/or platforms, based on innovative technologies, where people, possibly through an avatar as a visible representation of themselves, interact with each other or with digital systems, possibly blending physical and digital worlds in real-time. These interactions take place for a variety of purposes such as: designing, making simulations, collaborating, learning, working, socialising, entertainment, carrying out transactions, owning virtual property, using private or public services, and more.*

This definition differs from the European Commission's definition on the following main elements:

- **Deletion of '3D' and 'XR':** We note that the experience of immersion does not necessitate three-dimensionality. Consumers of video games and movies have for decades had immersive experiences with worlds that either *exist* only in two dimensions, or that exist in three dimensions while being *engaged with* through only a two-dimensional representation. For example, a two- or three-dimensional online video game experienced through a traditional computer screen (e.g., Second Life, World of Warcraft, Maple Story) can be highly immersive.
- **Addition of 'shared':** As elaborated below, we note that not all users engage with virtual worlds for the purpose of interacting with other users. However, to avoid broadening the definition to include also single-user virtual worlds that contain no possibility for users to interact with one another, we advocate for inclusion of the term 'shared' in the definition.
- **Addition of 'people interact with each other or with digital systems', and of 'possibly through an avatar as a visible representation of themselves':** While we agree that the *potential* presence of multiple users is constitutive of virtual worlds, users may also primarily engage with these worlds for the purpose of interacting with the digital systems they contain (e.g., games and reward mechanisms, video streaming, libraries and information archives, expert systems). In this sense, a user may be compelled to engage with a virtual world that contains the potential for interaction with other users even in moments when no other users are there. Building on this understanding, we further note that avatars, as representations of users that are visible to other users, are not a necessary feature of virtual worlds.
- **Additions to the enumeration of potential activities:** we note that the original list of enumerated activities excludes several potential use cases for immersive, persistent, and shared virtual worlds. We propose ending the definition in 'and more' to include also potential future use cases that cannot currently be foreseen.

Characteristics of virtual worlds:

In accordance with the offered definition, we view several characteristics as *constitutive or intrinsic* of virtual worlds, while several additional ones can be considered as *potential* characteristics that may further describe a virtual world (see **Table 1**).

Constitutive	Potential
Digitally driven: A core characteristic of any virtual world is that it is driven by digital technologies, even though a metaverse can be either fully digital or hybrid, i.e., parts of it may involve physical world artefacts enveloped in a wider digital setting.	Both digital and real: Virtual worlds offer an experience that spans both the digital and real world. This enables an emotional immersion in virtual reality. Synchronization: Virtual worlds may be experienced by multiple users in real time, but time-delayed interactions can also be highly immersive (e.g., playback of recorded video messages).
Immersion: The use of virtual worlds induces users to shift their attentional state from the physical world to the virtual world, at times resulting in deeper mental involvement in the virtual world than in the physical world.	Identification: Users of virtual worlds may be able to use real-world identities to reliably identify themselves in interactions with other users or with digital systems. Scalability: The network infrastructure of virtual worlds may be able to allow a massive amount of people to use it and interact through it simultaneously, without impeding the user experience or the system's efficiency.
Persistence: A user's assets and identity exist in virtual worlds (and can potentially be interacted with by other users) even between use sessions.	Accessibility: Virtual worlds may be accessible for all citizens, regardless of the devices they use or their physical and digital abilities. Interoperability: A virtual world may allow users of different hardware and software platforms to interact seamlessly, and to seamlessly migrate their data from one platform to another.
Shared nature: Virtual worlds have the potential to be accessed by multiple users, and these users may potentially interact with one another.	Economy: Users of virtual worlds may be able to produce, own, transfer (e.g., invest or sell), buy, or use virtual goods and services. Hybridity: Users of virtual worlds may experience them as a 2D representation on a traditional screen, as a 3D representation using virtual reality technology, superimposed onto the real world using augmented reality (AR) technology, or as a combination of these.
Dynamic: Virtual worlds may dynamically evolve and change continuously in time.	Decentralization: Virtual worlds and/or their associated virtual assets and user interactions may be hosted in Distributed Ledger Technology (DLT) networks. Depending on the specific governance structures of these DLT networks, virtual worlds and/or their associated virtual assets and interactions may be owned, administered, and maintained by decentralized collectives.
Ecosystem: Virtual worlds function as an ecosystem of various platforms and actors with different roles, where those different participants whilst having different objectives, contribute to the ecosystem and co-create experiences.	

Related concepts:

In this section we briefly elaborate on several additional concepts highly relevant for virtual worlds, such as simulation environment, digital twin and industrial metaverse. The ***simulation environment***, the ***digital twin***, and the ***industrial metaverse*** are all interrelated concepts that use virtual representations and cutting-edge technology.

These concepts are strongly dependent on the underpinning technology. Simulation environments and digital twins require advanced computing, modelling, and data integration to function properly. In the same vein, virtual worlds rely on cutting-edge technology to create seamless and immersive experiences across multiple platforms through VR, AR, and internet technology.

Despite their similarities, each concept has its own distinctive focus, purpose, field of application and scope of action.

More specifically:

- **simulation environments** are virtual spaces designed to simulate real-world/real life scenarios and systems to allow users to study, analyse and experiment complex situations and processes in real-time, making them beneficial in a variety of fields, including engineering, science, gaming, training, and research.

- **digital twins** are virtual representations of physical objects or systems enriched with data gathered from their real-world counterparts in the virtual realm. A Digital twin is capable of real-time monitoring, analysis, and optimization. It allows users to experiment, simulate and develop solutions in a controlled environment before implementing them in the real world. It provides valuable insights and support to decision-making and predictive maintenance in industries such as manufacturing, healthcare, and construction. Its applications can range from personnel education and training to process planning and design and production optimization.
- The **industrial metaverse** is a term that refers to a virtual version of the real world, specifically for the industrial sector. It is a new way to develop certain activities, where virtual environments can have a positive impact on industry efficiency, security, and sustainability.
- **Virtual worlds**, on the other hand, take virtual representations to an entirely new level. They constitute an interconnected and immersive virtual reality space comprising various virtual objects and interactions that transcends individual simulations and digital twins. Virtual worlds aim to create a digital ecosystem that is highly collaborative by providing users with immersive and interactive experiences. Besides replication and analysis, they foster a digital ecosystem where users can interact, socialize, create, and participate in diverse physical and virtual realms are seamlessly blended, creating a revolution in digital interactions.

In summary, these concepts aim to enhance understanding and decision-making by performing analyses and optimizing processes in their respective domains through simulation environments and digital replication of real-world contexts.

Annex 3: CitiVERSE definition and checklist

The definition of CitiVERSE is already expanding the notion of virtual worlds in the Cities and Communities field. However, this term does not yet have a widely established and agreed upon meaning. The term may gain relevance in the near future, with the European Commission supporting the EU CitiVERSE as a “flagship project of public interest”, or it could remain a niche term used within certain communities, such as the Living-in.eu Community.

Citiverse Checklist

For the purpose of this checklist, a CitiVERSE is a project to create a digital twin of a city, incorporating various layers of data, simulations, and interactive functionalities for urban planning and management. The table below shows a checklist of requirements that could be essential for CitiVERSE development. By following this checklist, a city can systematically approach the development of a digital twin, ensuring that it effectively supports the city's strategic objectives, and provides value to its citizens and stakeholders.

Topic	Action
1. Strategic Planning and Goal Setting	<ul style="list-style-type: none"> • Define the objectives and scope of the digital twin. • Identify key stakeholders and form a steering committee. • Develop a project timeline and budget.
2. Data Collection and Management	<ul style="list-style-type: none"> • Inventory existing digital and physical data sources. • Ensure accurate data for geospatial or Geographic Information System (GIS),

	<p>urban infrastructure (e.g. utilities and transportation networks), environmental data (e.g., air quality, climate data), socio-economic data (e.g., population density, land use), real-time traffic and public transit data, public service locations (e.g., schools, hospitals).</p> <ul style="list-style-type: none"> • Assess data quality, relevance, and completeness. • Implement data collection strategies for gaps in existing data. • Establish data governance policies and data management infrastructure.
3. Technology and Infrastructure	<ul style="list-style-type: none"> • Evaluate and select the technology platform(s) for the digital twin. • Determine hardware and software requirements. • Real-time data integration from IoT devices and sensors. • Ensure IT and data infrastructure can support data processing, (cloud) storage, and security needs.
4. Modelling and Simulation	<ul style="list-style-type: none"> • Develop or acquire models for different city components (buildings, transportation networks, utilities, etc.). • Integrate models into the digital twin platform. • Validate models with real-world data to ensure accuracy. • Simulation tools for scenario analysis (e.g., traffic flow, disaster response).
5. Integration and Interoperability	<ul style="list-style-type: none"> • Ensure the digital twin can integrate data from various sources and formats (e.g., CityGML for urban models). • Establish interoperability with other city management systems (e.g., traffic control, emergency services). • Develop APIs for data exchange and integration with external applications.
6. Visualization and User Interface	<ul style="list-style-type: none"> • Design intuitive user interfaces for different user groups (city planners, emergency responders, residents). • Implement visualization tools for data analysis and decision-making. • Augmented reality (AR) and virtual reality (VR) capabilities for immersive experiences. • Mobile and web access for broader usability.
7. Security and Privacy	<ul style="list-style-type: none"> • Implement security measures to protect

	<p>sensitive data and infrastructure.</p> <ul style="list-style-type: none"> • Develop privacy policies and ensure compliance with relevant regulations.
8. Testing and Quality Assurance	<ul style="list-style-type: none"> • Conduct thorough testing of the digital twin to identify and fix issues. • Implement quality assurance processes for ongoing data and model validation.
9. Training and Capacity Building	<ul style="list-style-type: none"> • Develop training programs for city staff and stakeholders on using the digital twin. • Technical support and maintenance plans. • Foster a culture of innovation and continuous improvement. Feedback mechanisms for users. Regular updates and upgrades based on emerging technologies and user needs.
10. Regulatory and Compliance	<ul style="list-style-type: none"> • Compliance with local and international data protection regulations (e.g., GDPR). • Adherence to urban planning and construction regulations. • Accessibility standards for inclusive access. • Environmental regulations compliance for sustainability features.
11. Deployment and Scaling	<ul style="list-style-type: none"> • Launch the digital twin with key functionalities. • Plan for scaling and future enhancements based on feedback and evolving city needs.
12. Monitoring, Evaluation, and Feedback	<ul style="list-style-type: none"> • Establish KPIs to measure the impact and performance of the digital twin. • Create feedback mechanisms for users to report issues or suggest improvements. • Regularly review and update the digital twin to reflect changes in the physical city and advancements in technology.
13. Stakeholder Engagement and Communication	<ul style="list-style-type: none"> • Plan for engagement with citizens, businesses, and other stakeholders to ensure the digital twin meets their needs. • Communicate the benefits and capabilities of the CitiVERSE digital twin to encourage adoption and support through educational materials in various medias. • Collaboration tools for stakeholder interaction.

14. Sustainability and Scalability	<ul style="list-style-type: none"> • Energy-efficient infrastructure and operations. • Plans for future expansions and integrations. • Sustainability features (e.g., support for green infrastructure planning).
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Annex 4 - Guiding questions for the expert group

To structure the work of the IFRAG, in the beginning of the assignment, experts were provided with a set of guiding questions and possible scenarios on virtual worlds to develop their work. These questions were of course adapted by the experts and discussed during the online and offline meetings of the IFRAG. The core guiding questions are included below.

1. What are possible scenarios for the development of virtual worlds in the short and medium term? Which scenario might be the most desirable? Which scenario is more likely to materialize? What might be the impacts on the social contract (the relationship between citizens, businesses and governments)? What are the risks and opportunities for public administrations and for the provision of public services - under the more likely scenario(s), or under all?
2. Is the existing body of EU legislation (including recent changes) sufficient to deal with the virtual worlds scenarios identified in the report? Are there regulatory loopholes to be taken into account?
3. Are there risks to stifle innovation? Which (kind of) innovation?
4. Do you see big gaps that should be addressed at EU level, particularly as regards the role of public administration, and the provision and management of public services in virtual worlds?
5. What are the ethical implications of using the CitiVERSE? How reliable are the possible scenarios from CitiVERSE simulations for policy decisions? How far can we trust these?
6. How can we ensure that principles such as empowerment and participation in the digital public space are respected? How can a human centric digital transformation be promoted?

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