D2.4 – The Roadmap for Open and Co-created Virtual Worlds (V1/M24)

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Abstract	This Deliverable builds on a large array of OPENVERSE contributions, either already achieved, including the technology foresight of Task2.4, or still ongoing, to design and detail the components of a recommendable roadmap for what the EU needs to consider regarding virtual worlds and the Web4.0. It encompasses actionable indications and a first threshold of recommendations. It was also nurtured by the insights of an expert workshop involving 48 participants. As it is, this Deliverable of M24 proposes the first formulation of the roadmap, to be put online for further expert discussions, as an intelligence resource to be fine-tuned, up to the last Task2.5 workshop of September 2026.
Keywords	EU, Policy, Roadmap, Foresight, Virtual worlds, Web4.0, Interoperability, standards, IPR, Open source, Open innovation, Digital Single Market, PPP, human-centric

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EXECUTIVE SUMMARY

This **OPENVERSE Roadmap 1.0** sets out a practical way for Europe to build open, human-centric and co-created virtual worlds that reflect European values while strengthening competitiveness and digital sovereignty. It is the result of 24 months of research, testing, and dialogue across the OPENVERSE project, and is written for policymakers and other decision-makers who need to translate an emerging field into near-term action and longer-term direction. The document explains **what should be done, why it matters, and how to organise delivery**, with Chapters 5 and 6 turning evidence into a phased programme and a clear plan for iteration and governance.

HOW THIS ROADMAP WAS BUILT

The roadmap draws on three complementary streams of evidence:

- **OPENVERSE results across tasks and work packages**, which provide a consolidated knowledge base on technologies, markets, standards and policy levers relevant to virtual worlds.
- **A technology foresight exercise** (four workshops, >40 experts) that developed three contrasted futures for the 2030 time horizon and additional insights specific to 2040, and a preferential, European "ambidextrous" track balancing innovation and proportionate governance. These insights anchor the roadmap's choices and timing.
- **Stakeholder co-creation**, notably **Workshop 1** (16 October 2025, 48 participants) and an ongoing policy dialogue. Workshop 1 validated priorities, instruments and progress markers, opening the way for the engaged expert community to pursue the necessary discussion to refine this first roadmap towards a final version in 2026.

THE STRATEGIC BACKBONE

Evidence converges on **five mutually reinforcing pillars** that connect policy intent to delivery:

- **Pillar A – Trust and Safety by Design.** Users will not stay without safety; makers and builders will not invest without clarity. The roadmap promotes visible safeguards, proportionate moderation and accessibility, with progress measured by concrete indicators (e.g., time-to-remedy, coverage of risk assessments).
- **Pillar B – Interoperability and Data-Readiness.** Interoperability is treated as plumbing. Priorities include identity and asset portability, usage control, and policy-enforcement signals, implemented through **conformance profiles**, plug-fests and open reference stacks aligned with European data-space approaches and emerging ISO/IEC guidance, also meaning that some sectors may play a pioneering role in terms of operability (healthcare, education, smart cities, industry).
- **Pillar C – Skills, Financing Tools and SME Scale-up.** Europe must build and stimulate, not only regulate. The roadmap links creator toolchains and interoperable asset libraries to Digital Innovation Hubs and a coherent financing path (EIC, InvestEU, EIT, ESIF), while using public procurement to create first markets for interoperable, accessible solutions and scalable options.
- **Pillar D – Science–Industry Testbeds and Sector Adoption.** Cross-border demonstrators in areas of European strength (health, manufacturing, education, cities, security) show how standards and skills come together in real settings.
- **Pillar E – Foresight-in-the-Loop.** Regular scanning, tripwires and annual refreshes keep policy agile and cumulative, ensuring that lessons from concrete deployments feed back into standards, funding and further guidance.

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FROM EVIDENCE TO ACTION: WHAT CHAPTERS 5 AND 6 DELIVER

Chapter 5 translates the five pillars into **ten Key Actions (KAs)** with clear impacts, indicative leads and target timelines. Together, they update the 2023 initiative to today's context—adding urgency on **sovereignty**, **professional deployments** and **environmental footprint**, while keeping **skills** and **interoperability standards** as near-term enablers. The actions are **phased**: enablers front-loaded (to **2026, expressing urgency or immediate measure initiation for longer-term expectations**), broader adoption and financing consolidation in **2028–2032**, and sector-scale outcomes thereafter.

- **KA1 — Build skills for virtual worlds; make the EU a talent magnet**

  Intended impact. A substantial increase in people able to act as makers, creators, brokers, counsellors, evaluators and researchers, with a visible (and assessable) rise in the number and originality of applications across key sectors. **Indicative leads/partners.** EU policymakers, industry, research, Member States, and sector actors (e.g. health, security). **Target timeframe. 2026–2032.**

- **KA2 — Promote guiding ethical and health principles for well-being in virtual worlds**

  Intended impact. Documented research on mental health and related risks; stronger medical and legal references; better protection enforced alongside higher privacy and trust, a case for proactive sandboxing. Indicative **leads/partners.** EU policymakers, research, health and legal sectors, user communities, education, and media. **Target timeframe. 2026–2028.**

- **KA3 — Promote inspiring partnerships across sectors and borders**

  Intended impact. New applications, markets and business models accompanying growth in users, virtual assets, communities, research output and IPR evidence. **Indicative leads/partners.** EU policymakers, industry, research, health, cities, Member States, finance actors, XR/VW associations. **Target timeframe. 2026–2028.**

- **KA4 — Help the Cultural & Creative Industries (CCI) and media test new business models**

  Intended impact. Creators and communities scale professional output (with or without AI); business models build on PPPs, blockchain-related communities and open-innovation schemes, as well as classical IPR. For AI and related IPR issues, dedicated farms with sandboxing capacities would be needed. **Indicative leads/partners.** EU & MS, media and culture sectors, education, finance actors, XR/VW associations, business schools. **Target timeframe. 2026–2030.**

- **KA5 — Develop standards for open/interoperable virtual worlds, with sandbox options**

  Intended impact. Measurable sector progression; **cross-use of virtual assets** becomes increasingly common and referenced; pilot incentives and support for XR/VW associations capable of scaling. **Indicative leads/partners.** Technology makers, industry, user communities, XR/VW associations. **Target timeframe. 2026–2030.**

- **KA6 — Promote AI integration and the corresponding skill building for VW creativity**

  Intended impact. Upskilling across roles (data stewards, ethics specialists, procurement experts, asset managers/brokers, AI-creation advisors, "avatar librarians", all of them with sandboxing capacities, etc.) emerges in numbers, reference tracking and follow up will be decisive. **Indicative leads/partners.** EU policymakers, researchers, technology makers, designers, education, industry champions, and security specialists. **Target timeframe. 2026–2028.**

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- **KA7 — Boost professional virtual worlds across sectors of excellence**

  Intended impact. Health, security, industry and city management achieve **measurable performance** and shareable experience, moving beyond dispersed experiments towards **professional ROI**. **Indicative leads/**partners**.** Industry, technology makers, designers, XR/VW associations, education, EU policymakers & MS, finance actors. **Target timeframe. 2026–2032.**

- **KA8 — Address sovereignty: promote champions; fight IPR theft, manipulation and misinformation**

  Intended impact. Priority support for EU champions (cloud, chips, AI, XR/VW); stronger capabilities to counter deepfakes, manipulation and mass misinformation, recognising AI as both risk and remedy. **Indicative leads/partners.** EU policymakers & MS, industry, finance, legal, defence and security, media, and education. **Target timeframe. 2026–2035** (we are engaged in a struggle that is both urgent and long-term).

- **KA9 — Support, refurbish and inaugurate new forms of financing for VW creators**

  Intended impact. Better visibility and uptake of existing instruments; **new schemes** launched to create a more stimulating environment vs. global competitors, with metrics on access and performance. In particular, the need to address the deficit in scaling financing means should become a strategic priority. **Indicative leads/partners.** EU policymakers & MS, financing organisations, pension funds, business schools, designers and makers. **Target timeframe. 2026–2028, and** then with due evaluation and correctives -2032

- **KA10 — Reduce the environmental footprint of XR/VW deployments**

  Intended impact. Moving from neglect or partial handling to **measurable management** of energy and **hydric (water)** has implications across devices, networks and data centres; prepare for emerging costs and standards. **Indicative leads/partners.** EU policymakers & MS, environment specialists, the energy sector, education, and research. **Target timeframe. 2026–2035.**

How actions become feasible. For each KA, Chapter 5 also lays out the **key steps** across five practical categories—**technologies; products/applications; markets; capabilities; regulation/stimulation support**—so policymakers and practitioners can follow the sequence from standards and tooling through to finance, procurement and uptake. This “actionability check” clarifies dependencies, time horizons and progress markers.

Chapter 6 covers **delivery and next step iterations**. The roadmap is a **living instrument**, supported by an **online platform** where materials, conformance artefacts, playbooks and KPI evidence are shared between the 2025 preparatory workshop and the 2026 final workshop, and then maintained in the OPENVERSE Observatory. This keeps policy responsive to technological, market and geopolitical shifts **without losing direction**.

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WHAT CHANGES FOR POLICYMAKERS

This roadmap invites policymakers to couple **policy instruments** with **practical infrastructure**:

- **Standards and data "plumbing".** Prioritise identity/asset portability, usage control, provenance and trustworthy data resources; publish conformance profiles and run plug-fests; align with data-space protocols so virtual-world deployments connect seamlessly to digital-twin ecosystems.
- **Legal sandboxes for responsible innovation.** Establish permissive, time-bound regulatory sandboxes that let innovators test new business models, identity frameworks, and asset systems under relaxed compliance conditions. Ensure that oversight focuses on learning, not penalties, so that EU SMEs and creators can prototype confidently within a trusted environment. Use sandbox outcomes to inform proportionate, innovation-friendly regulation.
- **Skills and finance that meet practice.** Link training to real testbeds; make funding pathways legible and coherent for SMEs and creators; combine grants, equity and first-buyer programmes to keep scale-ups in Europe.
- **A measurable environmental approach.** Track and reduce energy and **hydric (water)** intensity across devices, networks and data centres used by virtual-world solutions; publish sector-specific baselines and targets.

WHY ACTING NOW

Demand and capability are rising, and Europe has assets—research excellence, a strong industrial base, diverse cultures and a strong regulatory base—but outcomes will depend on execution: moving from general principles to standards that vendors can implement, demonstrator users can adopt, and finance that scales firms at home. The OPENVERSE evidence shows both interest and momentum across sectors; the roadmap turns that momentum into a sequence of near-term steps with clear responsibilities and progress markers.

To sum up, OPENVERSE Roadmap 1.0 is a workable plan: it links policy choices to real deployments, sets priorities for standards and skills, and builds an operating model in which foresight, evidence, and collaboration keep Europe on course as technologies and markets evolve. Chapters 5 and 6 give policymakers the tools to start now, while keeping the roadmap alive, testable and ready to be strengthened as results accrue.

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF TABLES

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ABBREVIATIONS

AI	Artificial Intelligence
AML	Anti-Money Laundering
AR	Augmented Reality
B2B	Business-to-Business
B2C	Business-to-Consumer
B2G	Business-to-Government
BAE	Business Angels Europe
BC	Blockchain
BCI	Brain-Computer Interface
CRA	Cyber Resilience Act
DAO	Decentralized Autonomous Organization
DEP	Digital Europe Programme
DGA	Data Governance Act
DIH	Digital Innovation Hub
DMA	Digital Market Act
DPIA	Data Protection Impact Assessment
DSA	Digital Service Act
DSM	Digital Single Market
EAF	EU Angels Fund
EBAN	European Business Angels Network
EDIC	European Digital Infrastructure Consortia
EDIH	European Digital Innovation Hubs
EEN	Enterprise Europe Network
EIC	European Innovation Council
eIDAS	electronic IDentification, Authentication and trust Services
EIT	European Institute of Innovation and Technology
ESIF	European Structural and Investment Funds
EU	The European Union
FRAND	Fair, Reasonable, And Non-Discriminatory
GDPR	General Data Protection Regulation
GPAI	General-Purpose Artificial Intelligence

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HE	Horizon Europe
HPC	High-Performance Computing
IEC	International Electrotechnical Commission
IP	Internet Protocol
IPR	Intellectual property rights
ISO	International Organization for Standardization
IoT	Internet of Things
KYC	Know Your Customer
LIDAR	Light Detection and Ranging
LLM	Large Language Model
MiCA	Markets in Crypto-Assets
MS	Member States of the European Union
MVP	Minimum Viable Product
NGI	Next Generation Internet
NIS2	Network and Information Security Directive
OS	Operating System
PoC	Proof of Concept
PPP	Public-Private Partnership
SRIA	Strategic Research and Innovation Agenda
TCP	Transmission Control Protocol
TRL	Technology Readiness Level
VR	Virtual Reality
WCAG	Web Content Accessibility Guidelines
XR	Extended Reality

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1 INTRODUCTION

1.1 OBJECTIVES OF TASK 2.5 AND DELIVERABLE 2.4/1

Analysing and emphasising the main tasks which the Task leader and its OPENVERSE partners have to carry out on the DoA basis, there is a set of requirements that can be efficiently specified as follows:

Main tasks:

1. Tasks defining or preparing for the strategic objective

    - Define strategic priority areas and application domains (based upon T1.1 and T2.3). Co-develop and finalise, through two dedicated workshops and the active participation of experts, a policy implementation process for the deployment of European Open and Human-Centric Virtual Worlds.
    - Synthesise this evidence-based policy and practice recommendations in the format of an actionable roadmap.

2. Tasks integrating several key OPENVERSE accomplishments

    - Leverage technology watch and taxonomy insights (market trends, benchmarking, standardisation efforts), involving several OPENVERSE task advances (WP2, 3, 5 and WP6)
    - Align with the exploratory studies and scenarios of the foresight exercise (T2.4)
    - Establish ethical, legal, IPR, and governance frameworks for open and human-centric virtual worlds (T3.4 and T3.5)
    - Build upon stakeholders' engagements and co-designed implementations developed by T1.3 and T4.3
    - Align with Policy Brief and Policy Dialogue endeavours (T7.2)

3. Tasks to make the roadmapping effective

    - Prepare a roadmap through a first validation workshop, integrating its findings into a draft Policy and Research Roadmap.
    - Disseminate this preliminary roadmap to stakeholders and similar initiatives for feedback (encouraging iterative comments and suggestions from the community to refine the roadmap on a dedicated online tool).
    - Increasingly align the roadmap with exploitation strategies, sustainability actions, and industry standards.
    - Build upon these comments and interactions to improve the roadmap and submit it in a final validation workshop, near the end of the project, with additions and corrections inputs as

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needed, taking stock of the evolution of the context in 2026 (at least until the end of the project).

- Consolidate the workshops' findings into a final policy and research roadmap, in a dedicated final Deliverable /D2.4/2_M36)
- Publish all findings in an easy-to-understand and follow format in the Project Observatory for open access and further multi-stakeholder uptakes and built-upon initiatives.

1.2 THE FUNDAMENTALS OF A ROADMAP AND ITS ESSENTIAL OBJECTIVES

A roadmap, in our context, is a metaphor borrowing, on the one hand, from the idea of a geo-physical journey that has to be planned, some essential features and supportive indications, and on the other hand, some distinct functional characteristics.

For the first part of this semantic relationship, it is quite easy to figure out the underpinning process at stake: one has a goal (we will come back to it), a starting point and, in between, a pathway with clear checkpoints (key places one has to preferably pass by). For the second part, it is less obvious, but anyone can understand that with the topic of how the EU has to strategise and build its strengths in the current arena of virtual worlds and the Web4.0, we are confronted not to a simple but **a complex pathway**, involving many processes, actors, and factors with not only important levels of uncertainty, but even more importantly, diverse effects we need to take into account which depend upon the actions of exogenous players (countries, companies, institutions, etc. that do not belong to the EU).

If we add to the situation as it is known today, with its current contextual uncertainties, possible exogenous changes still to come (grey or even black swans), the landscape we have to consider for our roadmapping task is not a stable one, but, on the contrary, a very complex one. It involves not only the purpose of (and the ideal plan for) the targeted pathway to the goal, but an important series of collateral processes likely to impact it along the way, i.e. with unexpected influences that may happen at a later stage, in the digital sphere (with the current discussions on AI, social media and content moderation, cybersecurity challenges, misinformation and fakes), as well as from a broader international societal perspective.

This complexity takes us away from the idea that a roadmap, in our case, could be a sort of algorithm to integrate various and open-ended complexifying factors:

- Multi-dimensionality (technological, but also geo-economic and sociological).
- A multi-stakeholder constituency with not one but several kinds of players likely to play a shaping role: policy-makers, public organisations and private companies, big and smaller, of some 25-30 economic sectors, as well as diverse types of associative communities and finally, end-users themselves, with roles that can easily shift between makers, designers and users.
- Competitiveness at the international level, with currently the strong push from the US to dominate and escape some EU regulatory requirements in quite a hostile manner, with consequences of various types, including in terms of research, at the talent recruitment stage and concerning environmental challenges.

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The co-creation of our roadmap will therefore have to examine, define and document the steps towards the goal, with some leeway allowing for the specification of **the conditions making possible a real advance, despite these different hurdles**. Essential micro-objectives, checkpoints, pilot programmes and extensions, scaling up stimulations, focuses on strengths and existing references, sandboxing options, etc., will help this process move in the right direction. **A roadmap aims to give actionable levers that can push us ahead in the most suitable way (at each conceivable step, closer to the goal to attain), at least in the short term. Still, also, of course, with some early considerations for the longer term's challenges and possible "black swans" we may have to cope with[1].**

The most important aspect of a roadmap of the kind is the actionability of milestones and the related dynamics which the EU can build upon promising next steps and advancements to the goal, and therefore, beyond the main role played by policy makers and decision makers of the economic arena, the integration of all the different players we have evoked earlier, so as to avoid making the roadmap only a top-down expectation. Then, there is the goal and the interpretation of the goal that can be reasonably reached in the short term. The goal, in our case, is defined by a series of official documents published by the Commission since July 11, 2023, on the topic of virtual worlds and the Web4.0. Associated with this concern, some key regulatory measures in the digital sphere, the importance of the Digital Single Market defined by the well-known Letta report, as well as the broad economic urgencies to cope with expressed by the Draghi report, were issued. The recent arm wrestling, which took place in the wake of the current US administration's efforts to redefine the framework conditions for how international trade will be carried out, made these initial references even more acutely important. However, when it comes to improving sovereignty in the digital sphere, there is still a long way to go, and objectives closer to us have to be defined, some of which concern the virtual worlds' domain. Similarly, if responsible, respectful, transparent, human-centric, inclusive digital behaviour is an ideal which we must pursue by all means, acknowledging that contrary forces are at work, it forces us to consider more pragmatic steps, and as much as possible, with measurables that can prove to us that we are progressing towards this ideal despite diverging or even adverse initiatives. The same could be said of the financing of digital innovation, or its environmental footprint. In other words, the roadmap must define ambitious and clear objectives fitting both the special focus we support and the overall societal concerns which the EU and the MS pursue, i.e. with a constructive vision of how the particular domain of virtual worlds will contribute to them, but also with intermediary steps that can demonstrate whether we are progressing in the expected direction or not.

[1] Although OPENVERSE is not strictly speaking a technological topic, as previous tasks in the project have shown the importance of non-technological factors in the shaping of virtual worlds, the focus remains strongly associated with the understanding, follow-up and assessment of diverse technologies, making virtual worlds consistent and attractive. Methodologically, worth referencing is therefore the seminal work published in 2004 as a special issue of the Journal Technological Forecasting and social change: Roadmapping: Form Sustainable to Disruptive Technologies" (Linton, Walsh 2004), with ten articles tackling this challenge with a variety of angles, concerns and epistemological issues being examined, that can inspire similar works, even twenty years later in an emerging domain like virtual worlds. The main underpinning schemes proposed are, on the one hand, how technologies, products and markets (in the large sense), are built into innovation dynamics and, on the other hand, the innovation life cycle with the intervening stakeholders: research, development, capabilities and requirements (which we can also translate into being the equivalent of the regulatory environment). We will have to come back to these fundamentals.

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1.3 METHODOLOGY OF THE ROADMAPPING PROCESS

A policy roadmap is a strategic textual and or visual document that outlines the key policies, initiatives, and milestones required to achieve specific organisational or governmental objectives over a target period. Typically, a "Policy Roadmapping 101" course would suggest outlining the following objectives and steps:

1. **Goals and Objectives:** Clearly define the overarching goals the policy aims to accomplish.
2. **Strategic Initiatives:** Outline the major policy initiatives or projects that will drive progress toward these goals.
3. **Timeline and Milestones:** Establish a chronological sequence of activities, including key milestones, deadlines, and phases to track progress.
4. **Stakeholders and Responsibilities:** Identify the responsible parties, including internal teams, agencies, or external partners.
5. **Resource Allocation:** Highlight the resources—financial, human, technological—needed at each stage.
6. **Evaluation and Feedback Mechanisms:** Incorporate metrics and review points to assess effectiveness and adjust strategies accordingly.

Given the topic we must address, i.e. the policy roadmapping of what the EU has in mind for virtual worlds and the Web4.0, we have to take into account that it is just one of the elements of the digital sphere (therefore sharing many of its underpinnings and objectives with other digital domains), which in turn is only one of the many factors composing the EU technological, economic and political landscape. As a result, our assignment is considerably more complex than this starting blueprint.

To take into account both requirements, we need 1) to anchor all these roadmapping components in the current EU endeavours regarding the digital stakes and how this perspective enters into a global discussion and negotiations with other major players of the planet, and 2) stage an effective working process to advance our understanding and expert/stakeholders enlistment towards concrete enacting possibilities.

The first requirement will almost certainly be global, with the digital sphere becoming part of larger political governance and economic discussions, and there is considerable uncertainty about how the situation will evolve and how it will affect digital developments. We must inventory and examine the landscape and establish short-term, agile goals that can serve as the bricks of ongoing negotiations and convey the EU's longer-term expectations. These targets should be verified and validated by predefined progression markers and kept open to re-evaluation rather than being rigidly fixed. Part of these factors will be, therefore, proposed for the working duty of the first and even, for some specific objectives to be fine-tuned, for the second workshop of Task2.5, scheduled in the autumn of 2026.

The second requirement is based on a sequence of two workshops with experts and representatives of key stakeholders (decision makers of the political and industrial arenas), separated by a one-year interval, to be exploited as a useful time for interactions and improvement of the preliminary roadmap generated as a result of the first workshop. Upstream of this concrete working sequence, the inputs must be, on the one hand, the diverse findings that the OPENVERSE project has already produced in its two-year duration (until the end of October 2025) and, on the other hand, a thorough examination

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and integration of the overarching goal and the different related sub-objectives to the EU on the focus of virtual worlds and the Web4.0. Let's specify that this particular assignment means, at the same time: to examine and eventually advocate for how the EU can help shape efficient capabilities in the domain of virtual worlds, and how virtual worlds, strategically envisaged and implemented, can help the EU develop an innovative industrial strength compatible with its values.

As for what the OPENVERSE project has already produced in the progression of its various tasks and work packages, we will take stock of:

1. Some 12 OPENVERSE tasks' contributions, half of them achieved, the other half are still ongoing. Still, they are already providing some significant insights, which altogether construct a solid threshold of findings and views on what is happening in the realm of XR and virtual worlds, with a focus on EU interests, of course (see for that section 2.1).
2. The deployment and results of a technological foresight exercise involving some 40 experts in a constructive sequence of 4 workshops, delivered at the end of April 2025, with scenarios and the advocacy of a preferential track for the EU regarding virtual worlds (see section 2.2).
3. A first report (the task is not achieved yet) of the OPENVERSE activity comprising the setting up of a Policy Dialogue and the production of three Policy Briefs on three key topics strongly related to the roadmapping objective (see further section 2.3)

The first workshop, as we will see in section 3, was conceived to make optimal use of the participating stakeholders' expertise, through a series of questions designed to address key challenging issues in an online, interactive process. The findings of this initial work will be presented in Section 4 of this Deliverable. Beyond this reporting task, these elements will form the backbone of the preliminary roadmap, which will be made available in a dedicated online workspace for expert guests and stakeholders. This shared space will support the engagement of relevant policy actors and enable the continuous refinement of the roadmap up to the final fine-tuning and validation workshop in Autumn 2026, which will produce the final Deliverable. This intermediate phase will also help the roadmapping process to adapt to any significant changes taking place in the environment -technological, economic or political- and likely to impact the future of virtual worlds and how the EU can build upon these digital developments for its own objectives in the most flexible manner.

Thus, at this stage, let's outline the successive steps and components which have made possible the build-up of the roadmapping process so far and will continue to prevail until the end of Task2.5:

- The preparatory document and knowledge made accessible not as final words but as stimulating content, building on OPENVERSE work, for most of it is still work in progress.
- The working mode of the workshop itself and its potential to translate most of the identified issues and challenges into actionable tracks.
- The dedicated and curated online space that will capture these initial inputs in the form of a preliminary roadmap and support deliberative and deep-dive suggestions.
- The last workshop, with policy-makers from both the EU and the MS, as well as the industry sector, is likely to fine-tune and/or validate these process results for an actionable proposition.

Keeping in mind this Task.2.5 journey, we can now move to Section 2, i.e. the OPENVERSE knowledge threshold on which to build our roadmapping endeavour. Section 3 will then examine the different components to be aligned, and further deepened, and thanks to the workshop (section 4), from a constructive perspective. **Section 5.3 will eventually present the roadmap proposal.**

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2 BUILDING ON OPENVERSE RESULTS: A SYNTHESISED KNOWLEDGE BASE

Task2.5 roadmap has not been written in isolation. It stands on two years of OPENVERSE work: research, experimentation, and dialogue, designed to turn a fast-moving topic into something "decision-ready". What follows distils that evidence into an actionable foundation for policy and programme implementation choices. We bring together, in this section 2, three strands of work. First, the project's own contributions: a structured platform scan; hands-on testing of shortlisted environments; ethics–legal–governance framing; small-scale user experiments on trust and identity; and systematic landscaping of standards and data-space approaches, all curated in the OPENVERSE Observatory. Second, a Technology Foresight exercise that stress-tested our assumptions across contrasting futures for the 2030 and 2040 horizons. Third, a Policy Dialogue, captured in targeted briefs, that translates barriers faced by SMEs and public actors into concrete measures. Together, these strands provide the purpose, context and evidence for the strategic moves proposed in this roadmap. This compiled work is presented in detail in Annex I of this document.

2.1 OPENVERSE CONTRIBUTIONS FITTING THE ROADMAP REQUIREMENTS

What was analysed, and for which reasons? We began with the landscape itself. Using a consortium-validated framework, we screened 118 virtual-world platforms, narrowed to 22 with genuine co-creation potential, and then to 8 chosen for hands-on trials. The lenses were pragmatic: accessibility, interoperability, identity and trust features, ethical posture, and sustainability, because those are the levers implementers can actually pull. The pattern was clear: while near-term traction concentrates in training, customer experience and collaborative design, the friction points are structural: skills gaps, fragmented standards and uneven identity/trust mechanisms that make cross-border use hard to scale.

Guardrails that don't kill immersion. Alongside this scan, we assembled a six-pillar ethics–legal frame: privacy and data governance; identity and anonymity; inclusion and accessibility; moderation and amendability; AI transparency; and legal interoperability. Such pillars were organised in an AI-assisted knowledge graph so that evidence is auditable rather than aspirational. Early user-level experiments (≈101 participants) add a human layer: visible, proportionate safeguards reliably raise perceived trust and safety without hurting immersion. For policy, the implication is to favour safety-by-design patterns (provenance and moderation signals; consent and usage controls) over blanket real-identity mandates that can depress participation while delivering little extra assurance.

Standards and data spaces as "plumbing". The standards landscaping, conducted in dialogue with ITU, ISO/IEC, W3C, IETF and 3GPP and drawing on community registries, points to four priority gaps where European coordination can change outcomes: identity and asset portability (avatars, credentials, objects), usage control and moderation (policy expression and enforcement signals), safety and provenance for synthetic content, and trustworthy data resources (quality, lineage, audit). Here, data-space thinking is practical, not rhetorical: an IDSA-aligned approach provides a GDPR/Data Act/DGA-compliant substrate for cross-platform exchange. Aligning with the Dataspace Protocol and emerging ISO/IEC guidance is a near-term win that ties virtual worlds to digital-twin ecosystems in sectors like health, energy, manufacturing and cities.

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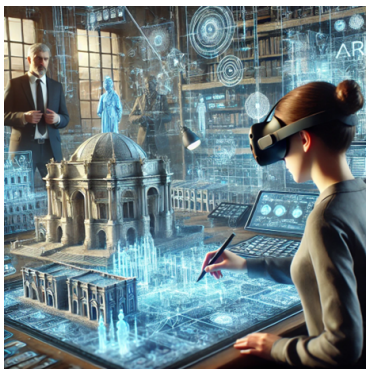
A living backbone. Finally, the OPENVERSE Observatory aggregates companies, platforms, standards, projects and funding windows under a shared taxonomy. It is designed as a low-friction, long-lived gateway: a place where profiles, conformance artefacts, demonstrator playbooks and KPI evidence can be published and discovered, so that policy iteration stays tethered to real-world uptake rather than to one-off reports.

1.2 BUILDING ON TASK 2.4: THE TECHNOLOGY FORESIGHT EXERCISE

Foresight was our remedy to short-termism. Over four workshops with more than forty experts, we worked with two horizons: 2030 operationally, 2040 for back-casting. We developed three contrasting scenarios. In **The Architect's Dilemma**, public authorities lean into sandboxed governance: innovation flourishes, but grey zones and overlaps proliferate unless someone coordinates. **The Price of Staying Human** imagines values-led governance with rigorous ethics in sensitive sectors: rights are protected, but commercial scaling slows and a shadow market emerges. **Echoes of the Past** extrapolates a convenience-first world dominated by global platforms: user agency and sovereignty erode; smaller EU innovators face scale barriers; psychosocial risks grow.

Scenario 1: The Architect's Dilemma (developing our ambidexterity)



Key characteristics:

- **Flexibility vs. predictability:** Adaptive governance must still provide legal certainty and investment security
- **Decentralisation vs. accountability:** Dispersed governance risks incoherence without clear coordination structures
- **Innovation vs. integrity:** The line between experimentation and exploitation requires constant re-assessment and self-reflexivity

Figure 1: The Architect's Dilemma scenario

Scenario 2: The Price of Staying Human (values will eventually make a difference)

Key characteristics:

- **Ethical coherence vs. operational agility:** High standards can slow down experimentation and market uptake
- **Global leadership vs. internal dissatisfaction:** External recognition clashes with domestic frustration over rigidity and complexity
- **Oversight without ownership:** Citizens are protected but rarely empowered to directly shape digital governance, too often lagging behind less restricted competitors

Figure 2: The Price of Staying Human, scenario # 2

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Scenario 3: Echoes of the Past (More of the Same)

		Key characteristics: ▪ **Convenience vs. Autonomy**: Individuals benefit from seamless digital services but surrender agency and data sovereignty. ▪ **Stability vs. Innovation**: Large platforms ensure continuity, but they stifle smaller-scale experimentation and cultural diversity. ▪ **Fragmentation of norms**: Conflicting standards on digital dignity, identity, and posthumous rights emerge across jurisdictions.

Figure 3: *Echoes of the Past* (scenario # 3)

To create a workable transition from the foresight exercise to the roadmapping needs, we elaborated a preferential track out of these three scenarios, or -said differently-, an ideal scenario (not a median way but an optimal combination of our initial sources), which goes as follows:

- Regarding regulation and innovation, **emphasising an ambidexterity requirement[2], with a governance grammar that is plural and evolving**, based upon flexible narrative tools to mediate between complexity and choices.
- **Targeting both human-centric and market-oriented expectations**, as well as supporting **SMEs but collaborating with emerging champions**, to keep learning the rules of the entertainment strand, but **developing more professional XR/VW applications**, and being always agile and future-sensitive, rather than fixed and constantly risking obsolescence or external dominating influences (e.g. interoperability as a learning industrial leveraging process).
- **Building on European strengths, not only the Single Digital Market, but also the most competitive sectors and value chains, science-industry collaborations, PPPs, dynamic communities of practice, pioneering regions and cities, as well as the diversity of social and cultural life,** meaning that education, in the sense of training, and creativity, should unfold with equal legitimacy, and that industrial strengthening in these diverse virtual and XR-augmented places, in policy terms, **should lead to incentivised co-innovation ecosystems.**
- **New financing means should come to strengthen the existing instruments and open innovation schemes to complement strict IPR objectives**, to boost the effects of the above-mentioned EU strengths, **involving a diversity of XR and VW designers and makers,** either as entrepreneurs or as communities.

This "ideal scenario", as the result of intensive expert co-design and co-validation steps, will be taken up as an initial threshold for the roadmapping duty.

[2] In this particular case, we can define ambidexterity as the capability for Europe to adopt a dual approach regarding its strategic objectives —supporting modular governance experiments and economic innovation while ensuring alignment with EU-level principles (human-centred design, ethics, digital sovereignty).

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2.3 THE POLICY DIALOGUE ACTIVITY AND THE POLICY BRIEFS

The Dialogue ensured the roadmap works for those who must act: SMEs and creators, platforms and standards bodies, public buyers and regulators. **The first brief** examined why cross-border business still feels like a labyrinth for immersive SMEs. Case studies (e.g., OneBonsai, Ready Player Me) highlighted predictable pain points, such as fragmented rules, uneven identity/interop, and choppy access to finance. The brief proposed four families of action: make the incentives visible (expand and clarify the funding pipeline for scale-ups); mind the gaps (harmonise criteria and simplify access across EU instruments); lead by example (codify SME-friendly regulatory guidance); and put money into the rails (invest in interoperable infrastructure and reference implementations). **A second brief** translates the "sandbox" idea into a voluntary pan-EU regime: real-world testing with built-in safeguards, so founders aren't punished for operating across borders. **A third policy** brief, due at M36, will tackle trust tools, from decentralised identifiers and verifiable credentials to privacy-enhancing technologies, aligned where relevant with the EU e-ID/eWallet and corresponding deployable measures.

2.4 FROM EVIDENCE TO ACTION: FIVE PILLARS FOR THE ROADMAP

What, then, should Europe actually do? The evidence above (platform tests and experiments; standards and data-space work; scenarios and dialogue) converges on five mutually reinforcing pillars. Below, each pillar is described in prose rather than lists so that the logic is easy to follow while the technical exactness is preserved.

2.4.1 Pillar A - Trust and Safety by Design.

If people do not feel safe (in the sense of privacy and integrity protection) and secure (in the sense of cybersecurity), they will not stay; if builders lack clarity, they will not invest. However, if everyone is only concerned with preserving safety and trust conditions, innovation can be killed. The goal of this first pillar is to make sure that all these requirements keep being aligned. The lesson from our experiments is to make safeguards visible, proportionate and also open to learning and flexible. This broad set of criteria also includes establishing robust cybersecurity principles to protect virtual world infrastructure and user data from threats. In addition, the roadmap should be encouraging provenance and transparency signals for synthetic and AI-assisted content; standardising moderation and "amendability" patterns, so harmful material can be removed with an audit trail; and baking accessibility and inclusion into the definition of "ready to deploy". Rather than mandating real identity everywhere, the roadmap favours pseudonymous accountability where appropriate, combined with consent and usage controls that travel with the data. Policy instruments here are sandboxes and reference implementations tied to procurement: a city or hospital that buys an immersive solution should be able to ask for a short list of trust features, and evidence that they work. Progress should be measured, not asserted: coverage of DPIAs and risk registers; the number and timeliness of transparency attestations; incident rates and time-to-remedy; and simple accessibility scores showing whether diverse users can participate. Eventually, the whole “Trust and safety by design” approach should also always be pondered by the need to avoid killing innovation as a development-minded guardrail.

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2.4.2 Pillar B - Interoperability and Data-Readiness

Interoperability is not a slogan but plumbing: the ability to move identities, assets and data across environments without starting from zero each time. The work on standards should head to where to begin: identity and asset portability; consent and usage control; policy expression and enforcement signals, while the data-spaces community offers the substrate. The roadmap, therefore, emphasises conformance profiles (clear, testable subsets of standards), plug-fests and open reference stacks that any vendor can implement. Alignment with the Dataspace Protocol makes virtual-world deployments intelligible to digital-twin ecosystems in priority sectors, reducing the integration burden on SMEs and public buyers. Here, success looks like fewer brittle integrations and more repeatable ones: more profiles published, more vendors conformant, more cross-platform asset transfers, and shorter onboarding times. The USB-C revolution could be re-applied to some stringent need that might make a difference, but then, European standard specialists should be the ones to make proposals in that sense, for a quick enforcement change for the better.

2.4.3 Pillar C - Skills, Financing Tools and SME Scale-up

Europe cannot regulate its way to leadership; it must build and stimulate entrepreneurship as a mindset and as a career. The policy dialogue is unequivocal: founders need a coherent pipeline, including skills, tools, finance and customers, without relearning the rules in every Member State. The roadmap, therefore, brings creator toolchains and interoperable asset libraries closer to DIHs and "test-before-invest" facilities, while linking them to a single, intelligible finance path that blends EIC, InvestEU, EIT and ESIF with angels and private equity (a sector which may also have to evolve, i.e. becoming more proactive and not just reactive, to avoid leaving all the funding opportunities on European soil to American venture capital). The procurement side matters as much as grants: public buyers can sponsor a first market for interoperable, accessible solutions if the guidance they receive is concrete and consistent. We will know this pillar is working if more firms are funded, more capital is leveraged, exits are possible in Europe rather than elsewhere, and a rising share of deployments sits on EU-based infrastructure.

2.4.4 Pillar D - Science–Industry Testbeds for enhanced Sector Adoption

To escape pilots-that-never-scale, demonstrators must be designed as value chains from the start. This roadmap proposes cross-border testbeds that link virtual worlds with data spaces and digital twins in sectors where Europe already has capability: health and care, manufacturing, cultural heritage, energy and cities. Higher Education and DEP calls finance the early nodes; ESIF and regional programmes help extend them; and standardisation bodies receive concrete inputs from what actually works. The pay-off is twofold: SMEs gain predictable routes to customers, and sectors gain shared language and reusable components. Indicators here are pragmatic: TRL lift across cohorts; numbers of SMEs onboarded; standardisation artefacts submitted and adopted; and time-to-pilot in real settings.

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2.4.5 Pillar E - Foresight-in-the-Loop for Blended Policy Operations

Finally, how Virtual Worlds and the Web 4.0 are governed must keep pace with how technology and markets evolve. Rather than treating foresight as a one-off, the roadmap embeds short, recurring foresight sprints into regulatory and programming cycles, so that sandboxes, standards' profiles and procurement guidance can be adjusted on evidence rather than intuition. The Observatory becomes the operational memory: a public place where profiles, conformance results, playbooks and KPIs are published, and where a "changes log" shows how insights have been turned into action. Healthy policy is iterative and flexible enough to adapt to fast-changing contexts; success here is measured in cycle time (from insight to updated guidance) and in the adoption capacity of those updates by buyers and builders. Foresight is not only about regulation, it should do more than foresee and follow up, i.e. proactively recommend some decisive and even urgent inroads, such as the support to European engines for gaming, or boost infrastructure for specific domains of applications, for instance, in 5-6 G for health, smart cities and industry. In addition, foresight should also be dedicated to helping people get out of their comfort zone, meaning, for instance, for the European industry, using the future to enlarge its mindset and sense of experience regarding investment, risks, science-industry alliances, international collaborations, including with extra-European players, to gradually head to a more proactive capacity of deploying skills and excellence.

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3 BUILDING THE ROADMAP: PREPARATORY COMPONENTS AND ISSUES

3.1 DEFINING GOALS, VISION, ISSUES, ACTORS AND STEPS

3.1.1 Introduction

We have considered the complexity of a potential roadmap in the context of the virtual worlds and the Web4.0, in the sense that it is not just a manufacturing plan with a fixed sequence of steps to produce a workable result, but a construction with several actors and factors to make the goal more accessible, concrete and prevailing. Here, we can underline a basic difference between a foresight exercise and a roadmap. A foresight exercise is meant to help stakeholders and, eventually, decision makers to prepare themselves for different futures, as a quite open field of possibilities, envisaged as a strengthening process for immediate or still to come decisions against the complex and uncertain evolution of the context, while a roadmap is the means, resources and combinatory sequence that may allow us to attain a certain goal, already more or less defined as desirable. Both knowledge operations are nevertheless useful and potentially complementary. In our case, the ideal scenario mentioned in section 2.2, as the result of our own foresight process, can be seen as a stimulating and challenging interpretation of the goal that the EU is pursuing. This contribution can enrich its formulation with a broad-lens perspective of what can eventually take place and possibly (positively or negatively) impact the goal to be reached, along the way or in further developments.

To make sure that all these inputs fit into their right moment and place, it is therefore necessary to define our tools, notions and their configuration in view of the goal to reach.

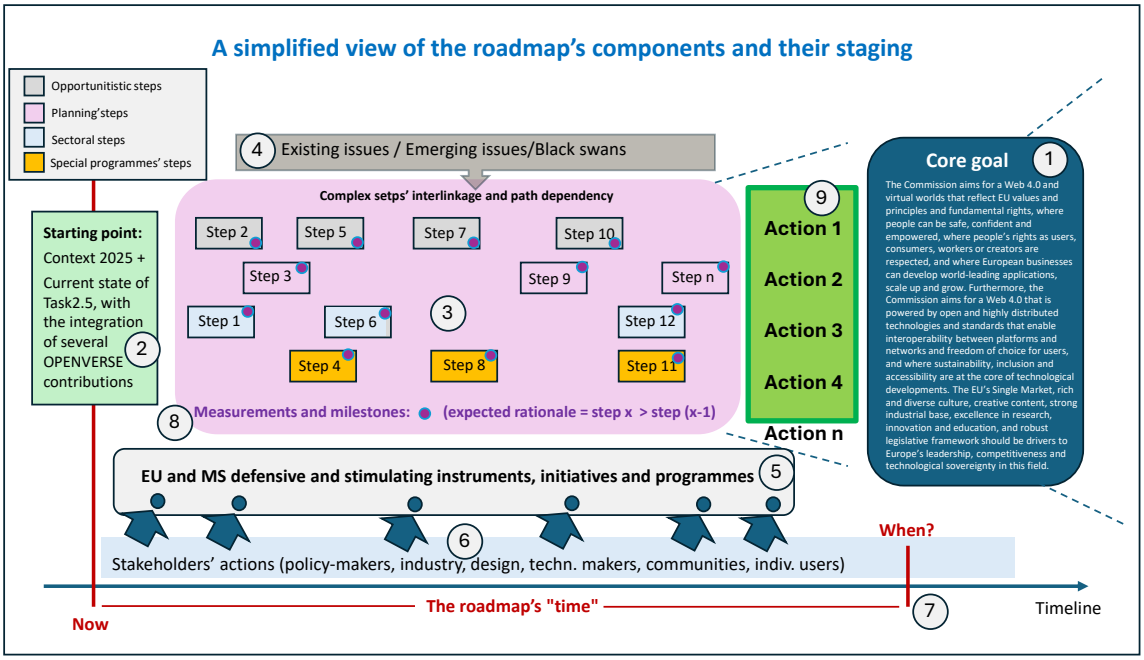

Fig 4. A simplified view of the roadmap's components to work upon

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Above, we can see a schematic view of all the components to be made cohesive, sense-making and effective, allowing us to specify them with a structured vision, namely the roadmap.

Let's examine these components, not in an abstract manner this time, but on the contrary, anchored in the EU perspective of its strategic needs regarding the virtual worlds and the Web4.0.

3.3.2 The Roadmap's Goal

As a brief reminder, in 2022, the notion of "metaverse" was becoming hot, with controversial announcements and comments, and the EU produced thereupon a concept of its own to define the objectives to be attained on its own terms.

In the wake of a series of workshops held with over 100 stakeholders from the end of 2021 until mid-2023[3], the European Commission launched the Virtual and Augmented Reality Industrial Coalition, bringing together industry and policymakers on 14 September 2022. In 2023, a new strategy on Web 4.0 and virtual worlds to steer the next technological transition was published on 11 July 2023.

This seminal work comprised a first compact formulation of a strategic goal, which goes as follows:

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

This threshold assertion should hopefully lead to:

- Building a talent pool of virtual world specialists
- Virtual worlds toolbox for the general public
- Empowered and protected children in virtual worlds, e.g., with clear age restrictions and identity authentication
- Business: supporting a European Web 4.0 industrial ecosystem
- Boosting the EU's technological capabilities

[3] In this formative context, let's also mention the early approach of the problem we tackle from the 1) European Parliamentary Research Service report on metaverses (Madiega Tambiana et al., 2022), expressing concerns on competition, data protection, liabilities, financial transactions, cybersecurity, Health, accessibility and inclusiveness, and 2) the analysis on the pluses and minuses of XReality produced for the EU Commission.by Visionary Analytics, Idea Consult (2022).

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- Government: supporting societal progress and improving public services
- Ensuring Governance at the EU and global level
- Monitoring the development of virtual worlds and Web 4.0
- Developing mechanisms aiming at anticipating and constructing new business models

It should also foster a supportive business environment:

- Encouraging innovation via regulatory sandboxes for virtual worlds and Web 4.0
- Supporting innovative SME and start-ups
- Facilitating the rise of innovative business models in digital services and cooperative models in industry
- Supporting Intellectual property in its various modalities
- Supporting the open-source community, including non-profits, professional and business associations and communities

The goal of what the EU intends to do with virtual worlds and the Web 4.0 challenge is then translated into ten key actions, on which we will have to come back in the end part of this document to evaluate how they can, or not, still be effective guiding recommendations for 2027 and beyond.

3.1.3 The Roadmap Starting Point

The starting point, for us, is, of course, constituted by our diverse sources and inputs:

- All the EU documents that have been produced after the July 11, 2023 seminal document, including the rich works carried out by the JRC (*De Hont I. et al, 2023 and Abendroth Dias et al, 2025)*, showed the quite promising sides of virtual worlds for EU development, and more generally speaking, also fitting this mindset, the recent EU **2025 Strategic Foresight Report** (The European Commission, 2025d), not focused on, but nevertheless relevant for virtual worlds**.**
- Other studies and reports on this topic have been published since the summer of 2023[4].
- All the relevant inputs from OPENVERSE partners in their diverse tasks, as presented in sections 2.1, 2.2 and 2.3.

The roadmapping engaged in Task 2.5, of which this Deliverable is a preliminary expression, before the final one of the Autumn 2026, is, therefore, built on all these inputs to define and align all the other components meant to advance the EU towards its goal.

3.3.3 The Steps Towards the Goal

As we are not in a strictly ordered plan, as a manufacturing or dam-building plan would be, we showed the steps likely to be considered as intervening at different successive moments of time, but being only loosely interconnected. Of course, when zooming into a particular linkage or sub-objective, more binding pathways can emerge. What is important here are the different kinds of steps which may have to be considered, as a minimum:

[4] We can include in this list the recent report by Virtual Dimension Center, Perey Research & Consulting (2025) on, if not all, mots protective regulation instruments for the digital world and in particular for virtual worlds.

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- Opportunistic steps: These are steps which may represent a real change but were not planned, just captured as they emerged. In a complex and uncertain context, this can happen any time and is typical of serendipitous agility.
- Planning steps: Just the opposite, these steps are planned and should take place as the momentary expression of a sub-objective prefiguring the final goal on its own terms. Typically, the unfolding of the AI Act is such a step. The set of planned steps, which, given the complexity of the topic we deal with, may involve tightly but also only loosely connected steps.
- Sectoral steps: Some sectors have quite naturally their own agenda and may sometimes develop quicker than the overall objective, under the pressure of context or innovative initiatives. For instance, the healthcare (and mental health in particular) or the defence sector may be accelerators.
- Special programmes' steps: At some point in time, there may be a need to regulate a problem that was not originally linked to virtual worlds, but which became a component of that development, although still treated in its own rationale and with specific underpinnings. It is the case, for instance, of all the MiCA or blockchain-related regulations, which have acquired increasing importance for the valuation of virtual assets in the real world. Cybersecurity is a similar example.

An important work, for which Task 2.5 Workshop 1 is a first building threshold, consisted in connecting some key progression steps, with effective instruments and stakeholders, to cope with existing issues and challenges. However, given the open and even highly uncertain and complex context in which our topic is unfolding, there is no straightforward way to do that. Below, following the dedicated literature (in particular Linton and Walsh seminal work, 2004), we prepared this "connecting the dots" step (workshop 1, then continued in the online platform discussion, see for that the conclusion section of this deliverable), according to different rationales, more complementary than competitive.

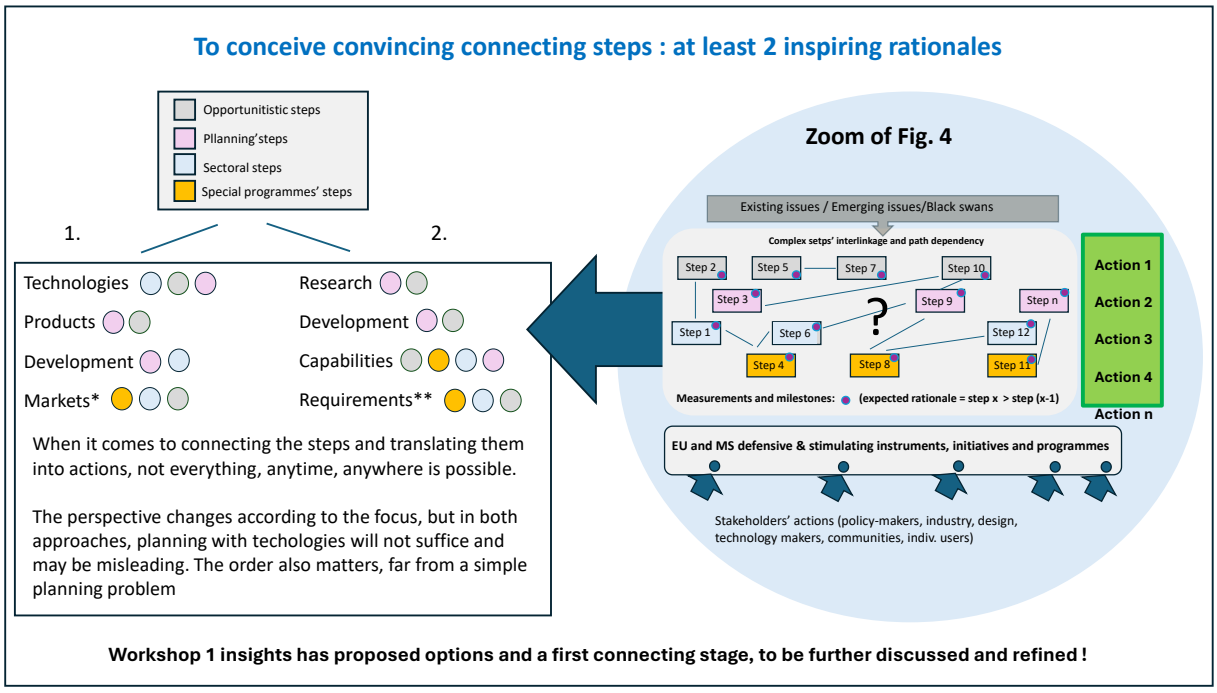

Figure 5: Multiple ways to connect the dots, workshop one will have to show the way

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The insights of workshop 1, analysed and reported upon in section 4, will provide us with the first bridging indications we need on how to best connect the roadmapping components. Now, if we refer ourselves to the EU goal concerning virtual worlds and the Web4.0, we have to pay attention to the **market on the one side** and to **requirements (or regulations) on the other side**. An interconnecting and synergy-bearing factor in this multi-rationale arena may well be **the capability factor** and how the stakeholders and the instruments which are accessible in the Single Market, and more specifically, to follow the Letta report, in the Digital Single Market, can **upgrade existing skills and boost their outreach**. Still, we will first see how our workshop one experts cope with this question.

Finally, the steps to target may also be envisaged as gaps to overcome. In this sense we have to distinguish 1) gaps that are continuously redefined by hostile actions or even innovations, such as what takes place in cybersecurity, 2) gaps that are at the moment difficult to eliminate such as for instance interoperability objectives, but for which partial progresses may already mean a lot, and 3) gaps that are within a certain lapse of time relay expected to be pu behind us (upskilling, professional virtual world developments, SRIA type of coalitions to compete at the highest level, etc.). As a matter of fact, in terms of gaps, some coming steps may make a difference, provided adequate supporting instruments, including financing innovation, and that stakeholders are determined and on time for that challenge.

3.3.4 The Key Issues Likely to Influence, Impact and Shape the Future of the Topic

There are dozens of issues related to the digital realm, and many of them can be found when it comes to examining the specific case of virtual worlds. In OPENVERSE, we have crossed and analysed them, for instance, in the initial analytical framework used for the first overview of 75 virtual worlds, then with the deep dive of 30 such platforms, to eventually shortlist 8 of them for co-creation purposes. In other tasks, for different reasons, other criteria were added, but at some point, it became urgent to limit ourselves to a relevant series of issues we could document and follow up, even if not fully comprehensive (but pragmatically effective and hopefully representing 70-80% of the possibilities). For Workshop 1 of Task 2.5, for instance, we retained 15 such issues, grouped in 5 categories, which go as follows, with comments on where we are at the moment (September 2025):

Table 1: The 15 issues, challenges and opportunities presented in the break-out session of Task 2.5, workshop 1

1. Risks	
1.1 Addictions	Virtual worlds, as they are importantly associated with video games and can constitute ludic immersive options on their own terms, fall into the category of incentives in terms of screen time, “pay to win” cases, and other dependency triggers.
1.2 Cybersecurity	Virtual worlds are part of exposed social usages of digital resources and, as such, do not escape the cybersecurity risks currently involved in those activities. Abuse of identities may even increase thanks to AI.
1.3 Privacy rights/ethics	All 30 virtual worlds are considered for our deep dive in Task 1.1. were GDPR compliant, which constitutes, in principle, a good safety net. There is no need to insist too much on the fact that part of the goal is even to strengthen this prevalence. Still, risks exist, and it seems to be a permanent struggle. Content moderation remains an acute concern, while a current

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	issue seems to be how to cope with cyberbullying in virtual worlds, with, for the moment, lagging legal options.
2. Hurdles & Gaps:	
2.1 VW and VW assets' interoperability	Interoperability is one of the great goals, but it is so difficult to achieve in a domain in which most platforms try to promote proprietary concepts of ownership. There are alliances, and the blockchain-based monetisation of virtual assets may also integrate cross-chain options. But this domain will not progress fast enough without strong policy and financial incentives, as the market is centrifugal by nature.
2.2 Languages, cultures, age classes	English is the rule, big countries are dominant, and as developing XR or VWs costs, there is a problem with supporting the cultural diversity of the EU with effective VWs, as well as attending some classes of age, seniors, for instance.
2.3 Lack of EU venture funding	This is undeniable, but the EU is really trying, in the context of support provided to digital makers, to develop new approaches, as the instruments examined in exercise 2 of Workshop 1 and detailed in Annex IV of this Deliverable show. What may be still lacking, given the amount and diversity of possibilities, especially for Start-ups and SMEs, is an overall guiding scheme on how these instruments could be better deployed.
3. Challenges:	
3.1 Talent shortage/brain drain	One of the biggest problems, regarding talent shortage and brain drain, but at the same time, one of the biggest opportunities if adequately supported at the EU level and even more at the MS level, with a diversity perspective on the variety of talents and specialities that are needed.
3.2 AI integration	A decisive and pivotal point that will change virtual worlds and not just for managing the VWs, but also for users, in the making of virtual assets, their management and monetisation, individually but even more so as communities. With open source, open innovation and DAO schemes, EU users and makers of all kinds have their chance to boost creativity and achievements.
3.3 Boosting professional worlds	This is a huge challenge, as so far, virtual worlds have been predominantly developed in the wake of video games and social media activities, but the EU definitely has a need for more professional virtual worlds and all the supporting applications that can boost them up. Clearly: a strong action point for our recommendation section, with some clues on how to go about it.
4. Opportunities:	
4.1 New cooperation models/DAOs	PPPs, but all sorts of community-oriented endeavours, Decentralised Autonomous Organisations (DAO) and any open innovation initiatives should be encouraged, despite the hurdles, as means of being part of a collective learning journey.
4.2 Science industry collaborations	Undeniably, a strong EU point, in which the Research support programmes (Horizon, but not only), play, alongside the MS equivalents, a key role, also to incentivise the industry being proposers (the market "pull" approach)
4.3 Data space/areas of excellence	Another strong EU point, to be encouraged and developed, with a tight connection with some previously mentioned issues (more professional virtual worlds, for instance).
5. Sovereignty issues:	
5.1 Champions	We need champions, more diverse types of champions directly or indirectly related to virtual worlds, capable of competing at an international level with foreign giants, but we also need dynamic value chains with good collaborations between champions and major industrial players, SMEs and even individual creators.
5.2 Material (e.g. rare earths)	There are several sovereignty issues likely to hamper the virtual world domain, for instance, the scarcity of access to key AI chips (Nvidia or AMD).
5.3 Immaterial (e.g. Cloud issues)	So far, the Unity engine is used by more than 60 % of virtual worlds, and the investment capacity of major US virtual worlds to integrate AI is tremendously above the EU players' bar; an EU Cloud solution and autonomous AI capacities seem to be essential to progress towards the goal assigned by the EU to virtual worlds and the Web4.0.

NB. Let's not forget two shaping factors, already analysed in our Foresight study, and that will make a difference in strategic deployment terms for most instruments and their effective leverage capacity: the Draghi and Letta reports published in 2024.

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3.3.5 The Different Stakeholders and Their Potential Role

Table 2: The key stakeholders to be considered

Stakeholder Group	Example Actors	Potential Role and Contribution
Policymakers & Public Authorities	European Commission, national ministries, regional digital agencies	Set direction and priorities for virtual-world development; provide funding instruments, regulatory sandboxes, and interoperability frameworks; ensure alignment with public values (openness, inclusivity, sustainability).
Standards Bodies & Governance Initiatives	CEN/CENELEC, ETSI, ISO, IDSA, Gaia-X, BDVA, Data Spaces Support Centre	Define and maintain interoperability standards, certification schemes, and data governance frameworks; enable alignment with digital-twin and data-space protocols.
Large Industry "Champions"	Meta, Siemens, Ubisoft, Dassault Systèmes, Nokia, or emerging EU leaders	Drive industrial-scale deployments, contribute infrastructure and R&D capacity, and support SME integration via open APIs and platform access; demonstrate global competitiveness.
SMEs and Start-ups	Independent XR studios, AI developers, creative tech firms	Bring agility, creativity, and specialised innovation; pilot novel use cases within sandboxes; scale solutions via partnerships with larger players.
Research & Academia	Universities, RTOs, think tanks (e.g., IDC, IFI, Fraunhofer)	Conduct foresight, benchmarking, and evaluation; develop methodologies, ethics frameworks, and human-centric design principles; contribute to education and training.
Associations & Industry Coalitions	XR4Europe, Metaverse Standards Forum, FIWARE, Creative Commons networks	Act as intermediaries and community builders; facilitate collaboration, events, and advocacy; connect diverse makers, from niche creators to established companies; promote collective learning and fair competition.
Creators, Makers & Developers	Independent artists, coders, designers, open-source communities	Experiment with tools, avatars, and content; innovate from the ground up; enrich ecosystems through creativity, interoperability, and cultural diversity.
Financial & Investment Actors	Public innovation funds, VC firms, banks, philanthropic foundations	Provide blended finance (grants, equity, procurement-based incentives); support early-stage ventures and sustainability transitions.
Civil Society & Citizens	NGOs, educators, cultural institutions, users' associations	Advocate inclusivity, accessibility, and trustworthiness; ensure human-centric values guide the evolution of virtual worlds; participate in co-design and governance.
Environmental & Sustainability Bodies	Energy agencies, environmental research groups	Monitor and improve sustainability metrics (energy, water, carbon footprint) across devices, data centres, and networks; define baselines and sectoral targets.

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All stakeholders are important, but even more acute is the need to generate creative dynamics, meaning that policy-makers and decision-makers of the private sectors have the duty to enlist, stimulate, facilitate, mobilise, support, etc., all the actors of our field who are needed to bring positive changes to the VW landscape. New performance levels, new initiatives, new applications will come from makers of all kinds who are not only motivated but encouraged to deploy their effort, individually and/or community-wise despite adverse forces and hurdles and in direction of much needed areas of activities: new for being new is not so important as strengthening existing strengths, developing creativity alone not so important as collaborating and federating creative endeavours, being trained and skilful not as important as deploying expertise capable of enhancing networks, value chains, partnerships, application transfers from a root domain to another area of need, etc. The mindset is the key, multiplying more decisively than adding, combining talents rather than stand-alone performance.

In this context, in which we will have to see how Workshop 1 treated that question of stakeholders and multi-stakeholder configurations, there is a category which is often not paid enough attention to: the associative groupings linked to XR and VW developments, rightfully identified in our Workshop 1/exercise one by many of our participants. These associations, events or coalitions may be European or international in the broader sense (with all the risks that are now underlined with legitimate sovereignty concerns), but they are important collective learning arenas. They tend to mediate several different types of specialities, geographical anchoring, organisational sizes, target domains of application and business models and the only threat surges when one of them pretends to be indispensable and unique to capture entrepreneurial motivations. This intermediation rationale can extend to sub-specialities of makers for makers with narrow focuses (a kind of avatars, for instance), alternative financial resource offerings or community-based propositions; in all cases, diversity is a strength[5].

Another type of stakeholders to be emphasised is the category of “champions”, meaning those big players already existing or soon to acquire that status within the European perimeter, who can pretend to compete at the highest level worldwide and who can relate directly or indirectly to virtual worlds. In fact, during our foresight preparation (Task 2.4, we identified such potential players, and even if the list is non-exhaustive, we reached a diversified pack[6] of more than 20 such champions. In the next step, i.e., between the two workshops of task2.5, we will have to make a deep dive into that category, not only to examine the collective capability they present, but also to explore how these big companies could complement with SMEs and VR/XR/VW associations, just as the incentive which the advocated SRIA project (for **Strategic Research and Innovation Agenda)[7],** is currently providing in the current European VW landscape (see: The European Partnership on Virtual Worlds - Open Verse).

[5] Different OPENVERSE tasks have tackled these associative configurations, so important in the context of virtual worlds’ future, see for that section 2.1.4.1.

[6] By diversified, we also mean the indirect players involved in key technologies such as AI, IoT, blockchain, 5-6G, robotics, EU cloud and edge options, and not just those directly involved in forms of XR/VW developments. We should also consider the companies involved in the making of digital twins and high-end healthcare or manufacturing robotics, big media players, as well as security and defence organisations, which can relate to our topic one way or another.

[7] Beside the EU support, worth mentioning are the founding members of that association: Siemens, SAP, VRT, CNRS, CNR, KU Leuven, Fraunhofer, DFKI.

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Having said that, we advocate the following approach: to consider that stakeholders are required by policy-makers and their operational agents, from top to bottom of the socio-political scale, as having to take their share of stimulating, framing and supporting contributions from all players. No one can do it alone, but rather has the duty of **making more people motivated and capable** of doing it.

3.3.6 The Time Issue

The strange thing about our topic is how time is itself a variable of the problem that should be addressed, if not "solved".

First question: when should the EU goal for virtual worlds outlined in section 3.1.2 be attained, and how can we even have an idea of when it will be attained? The first part of the question raises the issue of a time expectation for which success or satisfaction could be ascertained, but so far, we have no clue about when this could be, and the second part suggests having some indicators on which to rely to get oriented and have some confidence in where we are at the time of the roadmapping process. For the first part, if we do not have precisely time to think about, we can bear a qualitative idea in mind like: "if in five years from now (i.e. 2030-32)[8], we have not made the kind of progress which can give us the documented perception that we have attained 80% of our expectations, we will have a serious problem (of lagging, losing control, etc.)". In addition, for some other issues, like the development of Brain-Computer interfaces (BCI) and their possible future role in virtual worlds, as well as in other domains such as 6G or quantum computing, longer-term time targets have to be considered.

Second question: how to roadmap when the goal is not fixed in terms of time and verification?

Third question: The situation has changed quite a lot since 2023 (more uncertainties, EU digital compliance caught under the fire of broader geo-political negotiations, difficulty to build a cohesive EU front for existential industrial re-deployment, new doubts at social and environmental levels and a massive and fast-spreading misinformation context)[9]: should we keep the goal as it was formulated or should we update it? And if yes for this last question, in which direction?[10]

What makes timing even more critical is that industry actors outside Europe, such as Meta, Apple, NVIDIA, and Epic Games, are investing on decade-long horizons, building integrated ecosystems that combine devices, engines, identity frameworks, and developer communities. Their capacity to absorb long-term risk means they can shape markets before regulation or European coordination can catch up. This contrast highlights the need for strategic patience matched with decisive, early action: Europe

[8] We count time from the end of the project, i.e. to simplify, the beginning of 2027.

[9] The AI surge alone constitutes a pervasive game changer, barely perceptible for virtual worlds in July 2023, but two and a half years later massively impacts most human activities and organisations, including virtual worlds, and in many ways already identified, which we will have to take stock of, with great attention, until next Task2.5 Workshop.

[10] Our preferential track or ideal scenario emerged from our Foresight exercise has been conceived with that criterion in mind.

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must create the conditions for long-term investment, through stable policy signals, sandbox flexibility, and sustained public-private collaboration, if it is to remain a serious player in virtual worlds.

There is no strict answer to these questions; their value consists of being questions, precisely, that should be assertively and periodically asked.

3.3.7 The Metrics that Will Allow the Stakeholders to Evaluate the Progress Made

Let's consider the following retro-propagation rationale: the EU goal to be attained must involve a series of efficient actions that, in turn, suppose some steps which must construct the progression pathway, thanks to being supported by active stakeholders using specific means and generating thereupon innovative applications, gradually coping better and better with some key issues and making the best of available opportunities. This is the story suggested by Figures 1 and 6. To function, this backcasting deployment must be checked and validated by convincing metrics that indeed, it is not just a story and that at each step defined as referential points, the EU and its MSs get closer to their goal. The importance of being able to measure and document progress is therefore a decisive element in our roadmapping build-up. This is why, after the stakeholder roles and the EU instruments, we dedicated our third Workshop 1 exercise to that factor.

We distinguished quantitative from qualitative markers of progression. **Both are important and, to some extent, interact.** The examples for **quantitative measurements** we proposed to explain the purpose of the above-mentioned exercise are quite ordinary, but they must indeed be precisely ascertained: e.g. an increase in the number of users, virtual assets, professional virtual world applications, virtual assistants, active e-wallets, new talents on the market, etc.. The examples of **qualitative appraisal criteria** we suggested (we do not speak of measurement in this case): e.g. a virtual world success inspiring several other players elsewhere, a sector in which there is an innovative deployment, for instance for the environment, or for a specific industry, access to a library of virtual functions, etc.). Another series of examples has been given by Siemens in our foresight workshops: open standard deployment, new trust architectures, and proactive modular governance tailored to industrial-scale immersive deployments. This approach dovetails, indeed, with a broader EU reindustrialisation strategy in qualitative terms, although some of these suggestions may also involve quantitative metrics.

3.2 LOOKING FOR KEY ACTIONS TO GET CLOSER TO THE GOAL

No pre-emptive move should be pushed on the frontline that could short-circuit the value of the expertise collected in workshop 1 (see sections 4 and 5). Still, the process is quite obvious by now. We need to end up with not only a constructive script linking all the components inventoried so far, but also to be expressed in action terms. For that, we have the initial proposal of July 2023, with ten actions formulated, and for which some follow-ups and assessments could be made to check how things have progressed in two and a half years. We will do that. In addition, given the changes which have taken place, with more stringent sovereignty and industrial development requirements than ever before, with also the perspective to pay attention to growing issues such as the environmental footprint of the digital and, in particular, that of the virtual worlds and the Web4.0 (with its notion of pervasive and

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seamless interconnectivity) as well as diverse risks, flaws and divides, we need to envisage new actions not necessarily part of the initial list. Workshop 1 will provide us with insights and clues for that.

Finally, we will have to pre-evaluate the conditions of "actionability of the actions" (if one can say so), and we propose to make the roadmap effective, including the most plausible time perspective. This is what the section presenting the action part of the preliminary roadmap will look like, with a series of propositions and the guidelines to follow them over the duration.

Another way to interconnect and follow up our different components is to frame them within a consistent vision of what has to be accomplished, delineated here below as a socio-cognitive, technological and economic space to colonise and which we have sketched as follows:

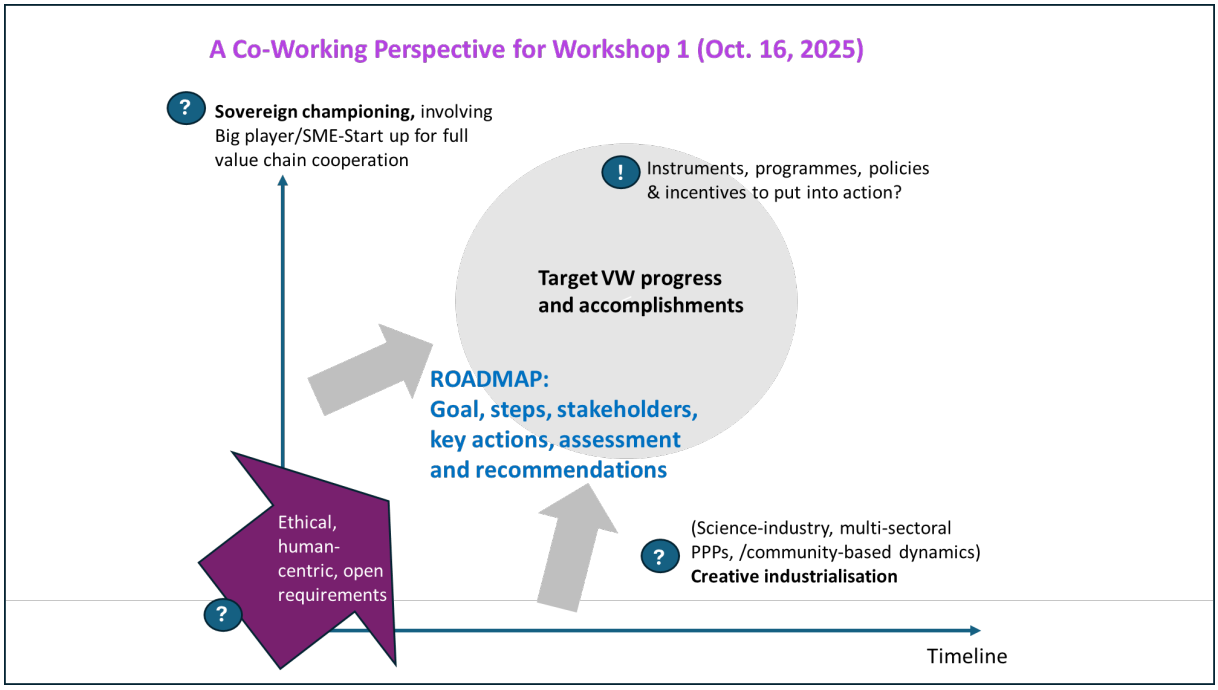

Figure 6: The Co-Working Perspective proposed for Workshop 1 of OPENVERSE Task 2.5

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4. BUILDING ON THE 1ST WORKSHOP AS A KEY CO-CREATION STEP

4.1 WORKSHOP 1 CONCEPT AND MODUS OPERANDI

The DoA requires that the Task 2.5 leader organise two workshops, one near the end of the project and another before Month 24, both intended to help co-construct and refine a roadmap and policy recommendation capacity.

In this sequence, Workshop 1 had a triple mission:

1. Get an array of experts covering a diversified policy and virtual world-related analysis and propositive capacity in view of co-shaping a roadmap for the EU.
2. Thanks to specific interactive exercises involving challenging questions regarding the future of virtual worlds, ensure these experts are tuned enough to make useful comments, suggestions, raise questions, and pinpoint issues we could have neglected, to help us construct a first roadmapping proposition.
3. Thanks to the interactions initiated and the knowledge-building impulse of this Workshop 1 momentum, continue to interact and nurture our collective reflection, to improve this preliminary roadmap made accessible on an online platform, and to eventually prepare the final workshop to be held in September 2026.

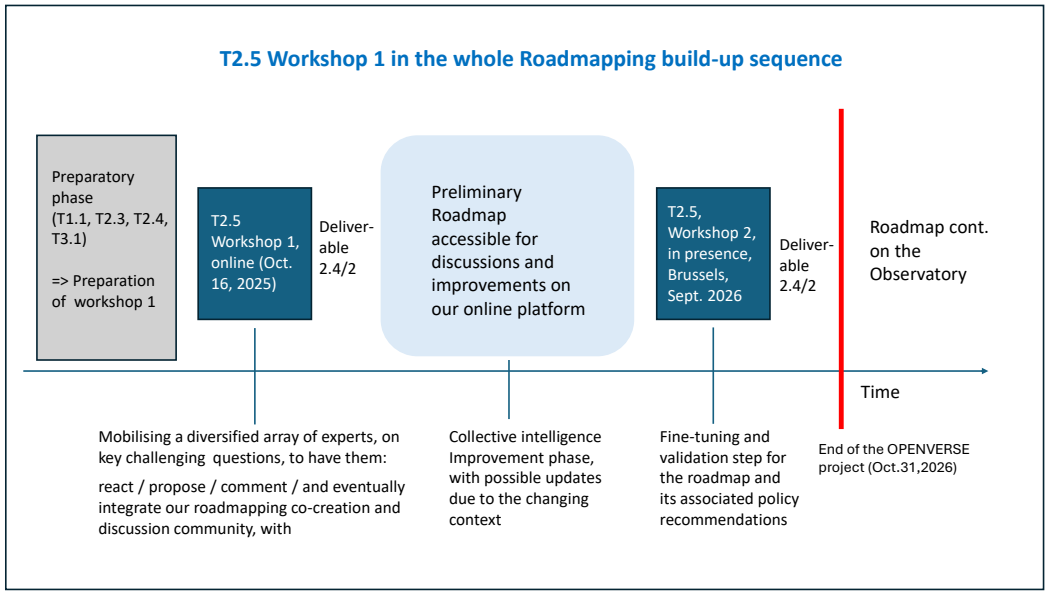

Figure 7: The full roadmapping co-creation sequence of Task 2.5

On the above diagram, we can see how Workshop 1 fits within a roadmapping and policy recommendation building process, with its mission being to enhance its level of relevance, coverage, and collective intelligence acuteness. However, the same Workshop 1, thanks to its results, i.e., the insights we captured from the different interactions that took place either in plenary or breakout sessions, also had a specific mission within this first Deliverable. Section 1 was designed to explain that roadmapping, in a complex context and uncertain political moment, entails a specific methodology. An

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essential preparatory step was also taken to assess the diverse tasks carried out so far in the OPENVERSE project, as summarised in Section 2 and fully accessible in Annex 1, which constitutes a de facto knowledge threshold for Task 2.5. Section 3 aimed at explaining all the constraints and knowledge components of the roadmapping process. This includes the EU strategic vision regarding the role of virtual worlds and Web4.0 in the future of the EU (the goal to be attained) and retro-envisages all the necessary steps and factors that would have to be taken into consideration to make the roadmap, strictly speaking. Section 4 presents the working features of the event, including the supportive aspects and working style dimensions involved, and reports on the insights and findings from this particular phase of Task 2.5. These insights contribute to the substance and immediate expansion of our preliminary roadmapping attempt (Section 5).

Duly prepared with careful selection and invitation, preparatory documents elaborated, some of them sent to the targeted participants, others meant to support the workshop roll out and productivity, and a series of internal OPENVERSE e-meeting, Workshop 1 was held as planned, online, on Oct. 16, 2025, online (14.00-17.00), with 48 participants (30 external experts and 18 OPENVERSE consortium members).

The workshop was chaired by Inspiring Futures (Gianluca Misuraca), who introduced OPENVERSE to the newcomers and explained the role of the workshop in the whole roadmapping sequence of Task 2.5 (see the diagram below). Pierre Rossel, for himself, presented the rationale and findings of the foresight exercise conducted through OPENVERSE Task 2.4, one of the key preparatory knowledge components for the workshop. Then, after a detailed explanation of how the interactive sessions would unfold, with clear visuals and examples, and how each participant could make the best of it, the breakout sessions began, lasting one hour.

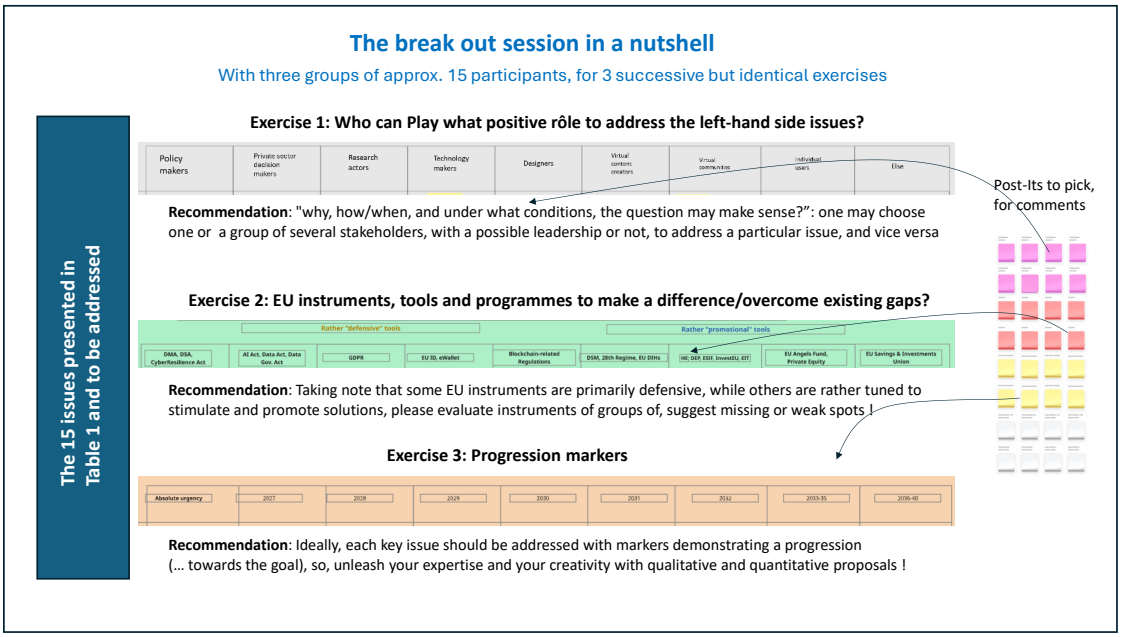

Fig. 8: The breakout session, with its three exercises, in a nutshell

The three exercises were conceived to encompass a progressive level of difficulty, with exercise 1 associating at best, with due comments and suggestions, the 15 issues to be tackled with specific stakeholders or groups of stakeholders and the possible leaderships and roles, while the two exercises

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following this warm-up step involved more fine-tuned reflections which could directly feed the roadmapping process and actions to be recommended.

The plenary sessions, which followed, began with three 10-minute reports from pre-designated rapporteurs (who had a time-out to prepare their brief reports) and then a general discussion. The following steps for the workshop, particularly the possibility for all participants to continue discussing the ideas, results, and even the roadmap proposal on an online platform, were announced before the formal closure of the event.

The findings, which will be presented in the next section, will comprise both the knowledge production of the breakout session exercises and the plenary accounts and discussions.

4.2 KEY ISSUES TACKLED AND KEY FINDINGS OF WORKSHOP 1

4.2.1 Channelling and Exploiting a Rich Production

Let's gather 48 experts on a given topic, who will virtually meet for three hours, answer questions, provide comments, and discuss the results. You will have a considerable amount of information to exploit, categorise, prioritise, and make sense of, even if the initial goal and working methodology were well-defined.

We have basically two information sources available: 1) the Miro Board: in our case 3 groups having tackled three similar exercises (the break-out session had the same assignments; they were three only to create more manageable groups), producing collectively 300 + post-its; 2) the recordings and therefore the transcript of the conversations having taken place during the break out sessions, with also the three plenary reports upon the insights of these separate working rooms and the final conversation. Let's be honest, the conversational level, precisely because it is casual and interactive, is full of good ideas but in a very unstructured manner (even the break-out session reporting contains discursive small talk, quite a normal rendering in those circumstances). As a result, our exploitation plan is to utilise the Miro board first, also using it as a structuring framework (it was designed to serve that purpose anyway), and then add what can be extracted from the conversational level.

The Miro Board production, like a Sudoku challenge, can be "read" and made sense of, both horizontally (the lines of comments corresponding to each issue of the 15-issue list on the left-hand side of our murals) and vertically (from the top horizontal list, from each increment or item, the possibility to see how all the answers of the corresponding "column" can provide us with interesting insights). However, the main analysis thread we adopted was to rely on the fact that each exercise raised one key question, which tended to "federate" the post-it comments in a consistent manner, allowing for meaningful analysis. These key questions can be considered "attractors," and the post-its can be viewed as variations of viewpoints and insights surrounding them. Following this order and leaving options for the other perspectives to complement the core findings, we can proceed step by step. In our case, exercise after exercise.

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4.2.2 Exercise 1 — Who Should Act on What (Stakeholders × Issues)

The Miro board, on its horizontal axis, listed a series of stakeholders, while the vertical axis, as with all exercises, presented the 15 issues outlined in Table 1, Section 3.1.5 of this Deliverable.

We can observe from the location of the different comments that the distribution was quite uneven:

The most populated buckets were **Hurdles & Gaps (97 notes)**, Risks (87), Challenges (55), Opportunities (24), and **Sovereignty (11)**.

Within these, the top sub-issues were:

- **1.1 Addictions** (47) and **1.3 Privacy/Ethics** (29), with **1.2 Cybersecurity** (11) also present → a strong *safety & wellbeing* focus.
- **2.3 Funding (VC/EIC/etc)** (36), **2.2 Language/Culture/Age** (31), **2.1 Interoperability** (30) → structural enablement.
- **3.2 AI integration** (39), then **3.1 Talent/Skills/Drain** (8), **3.3 Boosting Professional VWs** (8) → capability and market fit.
- **4.2 Science–Industry Collaboration** (16) → ecosystem building.
- **5.3 Immaterial Sovereignty (Cloud/Chips)** and other sovereignty notes (low volume) → strategic exposure acknowledged but not deeply debated.

Sovereignty has become a contentious issue, given the evolution of the overall geopolitical and economic context. However, it appears that the means to address these issues adequately are still lagging, a trend that we have also observed in other OPENVERSE tasks and elsewhere (in other EU discussion contexts). This gap should be addressed in the roadmap. What we have seen in the post-its is the acknowledgement of some contradictions among XR/VW operators related to this concern. A demand: the acceleration of an EU Cloud solution (but how to answer that: status of Gaia-X?[11]) and others for “long-term friend shoring for rare earths” and for “European chip manufacturer suited for AI”, to show the spread of the issues to be envisaged.

Science-industry collaborations are not as important as the most commonly identified risks and flaws, and, given the fact that this linkage constitutes one of the most undisputable strengths of the EU perimeter, we can also assign to the roadmap the capacity to envisage supportive actions. A comment also suggested not to forget the need for international collaborations, beyond the sole EU perimeter. Sovereignty is a complex issue (but, to follow another comment: apply EU value concerns to these more international collaborations).

As for the rest, they seem to be equally shared (including "Language/Culture/Age" and “Interoperability”, with some structural enablement required[12]), with, interestingly, expressive capabilities almost as important for the need for funding, supporting AI integration (here, too, with

[11] From what we can follow, Gaia-X, as a EU sovereign cloud solution initiated in 2020, is (starting to) being deployed, but still faces some hurdles and alignment issues.

[12] The problem of being caught in a vendor lock.in relationships has been raised.

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requirements for better business case interconnections)[13] and talent shortage, as for the hurdles, risks and flaws (for which some effective metrics is also asked for!)[14]. We will see if the other exercises confirm that trend. Let's recall that the first one had, to some extent, the status of a warm-up moment, with the next two exercises being more complex to cope with.

Now, who is expected to lead what?

- **Privacy/Ethics, Cybersecurity, Interoperability:** primarily **policymakers** plus **security & standards organisations**; technology makers are expected to implement "by design".
- **Addictions/mental wellbeing: policymakers** (public-health framing), **researchers/health agencies** (evidence & guidance) and **platforms** (feature design, transparency).
- **Funding & scale-up: accelerators/VCs**, **EIC/InvestEU/EIT/DIHs**; policymakers to tune instruments and remove frictions.
- **AI integration: researchers** (methods, evaluation) + **technology makers** (tooling, agents), with light guidance from policymakers.
- **Inclusion (language/age/disability):** shared—**policymakers** for accessibility norms; **standards orgs** for requirements; **makers** for usable defaults.

We can see, not surprisingly, that a lot is asked of policy-makers, including supporting more proactively XR associations, taking more responsibility for funding and scale-up actions (a recurrent theme since our Foresight exercise), not forgetting public health concerns and also promoting open technology standards (Open XR, 3D, LIDAR, etc.) and asset portability[15]. For technology makers and platforms, there were interesting remarks concerning the need for light guidance (more flexibility within grants and better connections between interconnected projects) and allowing them to strive for ownership lines for *interoperability* and *AI-by-design*.

Let's also note that a recurring practice throughout the three exercises is the mention, shared either in a post-it or in the chat, of existing work or associations already active in addressing some of the 15 issues. Two interesting examples (but there are several others): 1) concerning the interoperability groups of the Edtech arena: European Edtech Alliance Projects Overview — European Edtech Alliance, 2) concerning blockchain developments, the INATBA Vision 2029 and the Global Forum Initiative, INATBA - International Association for Trusted Blockchain....

[13] Interesting: For Ai, several post-its suggested the need to establish the difference between creation made by humans and made by AI.

[14] In the same line of thinking, a demand was expressed for more engaged and verified inclusivity by design ("from representation to agency") and not just suggested. Another converging demand: rewarding mechanisms for whistle blowing and reporting. Others asked for certification rules concerning the values that are required (inclusiveness, transparency, etc.) and accountable metrics proving these claims, also with a necessary openness to the intersectionality of these risks and flaws.

[15] When post-its say "promote", for the roadmap, this raises the question : with what kind of incentive?

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4.2.3 Exercise 2 — Which EU Levers Fit which Issues (Instruments × Issues)

Not surprisingly, the attention focused on defensive instruments rather than on proactive and solution-promoting ones.

- **GDPR / DSM / 28th regime / DIHs / HE / DEP / ESIF / InvestEU / EIT** (26 combined references),
- **AI Act**[16] **/ Data Act / Data Governance Act** (13),
- **DMA / DSA / Cyber Resilience Act** (12),
- **Blockchain-related frameworks (incl. MiCA context)** (8),
- **EU Angels & Private Equity** (4),
- **EU Savings & Investments Union** (4),
- **EU ID/eWallet** (4).

How to explain that? One simple hypothesis is that the stimulating instruments are less well-known, more recent, and also, many of them involve coordination between the EU level and the MS level, which is not a simple endeavour to achieve. However, in roadmap terms, as the need for more funding options has been raised on various occasions during the OPENVERSE project, including, of course, in the foresight exercise (a full section is dedicated to that issue), there is a need to strengthen, expand and better promote existing funding means (several post-its in support of these ideas). In other words, there is a need for more support, even for innovations and applications at the TRL4-5 level. The biggest gap, according to one comment, is the scale-up/growth stage. Finally, one suggestion worth mentioning is that EU bonds should be used to fund innovation.

How the group paired them (emerging consensus).

- **Privacy/Ethics, Cybersecurity, Addictions** → **defensive** levers: **GDPR**, **AI Act** (risk tiers, transparency[17]), **DSA/DMA** (platform duties), **CRA** (product security). *Promotional* R&I (HE/DEP) funds pilots and evidence on harms/mitigations.
- **Interoperability and Open Interfaces** → **DSM logic & 28th-regime sandbox** (for cross-border trials), **DEP** (test-before-invest), **HE** (standards research), **EU ID/eWallet** (identities & consent signalling). Identity tokens for interoperable avatars also bring the seriousness of credentials in virtual worlds' interactions and deals.
- **Funding & Scale-up** → **EIC/InvestEU/EIT/ESIF/DIHs** and **Angels/PE**; some participants floated **ESIU**-type products to mobilise retail and institutional capital.
- **Science–Industry Collaboration** → **HE/DEP/ESIF/EIT** to create testbeds and translational pipelines; DIHs as entry points for SMEs, and the need for incentives. DEP is essential to provide trust in PPP collaborations.
- **Sovereignty/Cloud/Chips exposure** → mainly **promotional of** industrial instruments (DEP/ESIF/InvestEU/EIT) with standards & procurement nudges; defensive measures (DSA/CRA) ensure resilience.

[16] Worth mentioning: a comment on the AI Act, with emerging issues. Another comment expressed more precisely that the AI Act may clash with user co-creativity and user-generated content ecosystems. Nothing is perfect, but there is a concern about how the AI issue should be best tackled, although acknowledging it should be tackled.

[17] An interesting comment worth mentioning: How to make AI in virtual worlds understandable without disrupting the immersive effect?

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Strangely enough, we found, in that dispersion of attention, the same pattern as in exercise 1[18]. However, what appeared as a stimulus rather than a conservative view is that the group, collectively, seems to recommend a **blended policy mix**: use **defensive** regulation to anchor *trust & safety* and **promotional** instruments to unlock *interoperability, capacity and scale-up*. No single lever is sufficient on its own. This advocates for going in the direction of an ambidextrous scenario, converging with our past proposition (foresight exercise).

4.2.4 Exercise 3 — When and How to Measure (Indicators × Timeline/Urgency)

To address the key question, participants placed their ambitions along the time-marking band and proposed what to measure. **Timing mentions** concentrated in **2028–2030** and **2031–2035**, with some **near-term (by 2027)** milestones and a handful in **2036–2040**. Explicit **"Urgent"** tags were rare (5 mentions), so urgency will need to be emphasised in the write-up of the next section to indicate a fit with the roadmap timeframe.

4.2.5 Theme-by-theme indicator directions:

- **Privacy/Ethics & Safety-by-Design**
  - *Quantitative:* % of major VW providers with **DPIA/AI risk registers**; # of **transparency attestations**; **incident rates** and time-to-disclosure; share of **WCAG-aligned** assets.
  - *Qualitative:* availability and uptake of **safety playbooks**; quality of **meaningful consent** flows; user wellbeing signals on persuasive features.
  - *Timeline:* **Guidance/guardrails by 2027; mainstream adoption 2028–2030; consolidation 2031–2035.**
- **Interoperability (avatars, assets, identity, data)**
  - *Quantitative:* # of **conformance profiles** published; # of **vendors conformant**; # of **cross-platform asset transfers**; **onboarding time** across platforms.
  - *Qualitative:* developer satisfaction; clarity of IP/licensing norms for assets.
  - *Timeline:* **Pilots by 2027; scaled profiles 2028–2030; broad market uptake 2031–2035.**
- **Addictions & Mental Wellbeing**
  - *Quantitative:* prevalence metrics (screen-time/addiction proxies); # of **certified clinical/educational apps**; referrals to support services.
  - *Qualitative:* design norms for **persuasive features**; clinical guidance adoption.
  - *Timeline:* **Evidence & certification pilots 2028–2030; mainstreaming 2031–2035.**
- **Funding & Scale-up**
  - *Quantitative:* # of **EIC/InvestEU/EIT/DIH-supported** VW firms; **€ leveraged**; # of **EU-based exits**; **share of EU cloud/infra spend**.
  - *Qualitative:* founder experience with EU instruments; friction points removed, new business models encouraged.
  - *Timeline:* **Pipelines now through 2028–2030; late-stage financing 2031–2035.**
- **AI integration**

[18] There is, behind that trend, another hypothesis: people tend to read anything, in our culture at least, starting from left to right and top to bottom, therefore paying less attention as they progress towards the right-hand side bottom part of the murals.

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- *Quantitative:* # of **real-time AI** use cases deployed; latency/throughput targets; share of **safety-documented** AI features.
- *Qualitative:* human-in-the-loop patterns; red-teaming coverage.
- *Timeline:* **Continuous; first robust "agents in VWs" wave by 2028–2030.**

- **Science–Industry Collaboration**
  - *Quantitative:* # of **testbeds**; TRL progress; # of **SMEs onboarded**; # of **standards contributions**.
  - *Qualitative:* sector case maturity (health, culture, manufacturing); diffusion to regions.
  - *Timeline:* **Seed nodes by 2027; networked testbeds 2028–2030; sector scale-out 2031–2035.**
  - *Needs to be better assessed.*
- **Inclusion (language/age/disability)**
  - *Quantitative:* % content with **multilingual support**; # of **accessible input paths**; user satisfaction by demographic.
  - *Qualitative:* co-design with target groups; availability of assistive tooling.
  - *Timeline:* **Ongoing; minimum bar by 2028; continuous uplift to 2035.**
- **Sovereignty (cloud/chips/champions)**
  - *Quantitative:* **EU vs non-EU cloud share** in VW deployments; # of **EU champions** participating in standards; resilience indicators.
  - *Timeline:* **Longer arc** (2031–2035 and beyond), while encouraging near-term procurement and standards participation.
  - *Concern for dependency issues at large, but in particular regarding XR technologies.*

General lesson. The board implicitly prioritised **near- and mid-term deliverables (2027–2035), where policy, standardisation, and funding are two concerns that should move fastest.** However, let's stress that it pushed deep sovereignty goals later, while still encouraging early pilots and procurement signals.

4.2.6 Cross-Exercise Synthesis

Let's distinguish the Miro board comments from the conversation that accompanied the break-out session and continued in the plenary.

Below are the cross-cutting themes that the 300+ post-its of the three groups and three exercises have pointed out:

1. **Trust-by-Design First.** The strongest energy lies in **Risks** (Addiction, Privacy/Ethics, Cyber) and in **Hurdles & Gaps** (Interoperability, Inclusion, Funding). Treat these as **Pillar A & B** of the roadmap, backed by **GDPR/AI Act/DSA-DMA/CRA** and **HE/DEP/DIHs** pilots; measure DPIAs, transparency, accessibility, incident rates, conformance, and onboarding time.
2. **Blended Policy Mix.** Participants consistently suggested pairing **defensive** regulations with **promotional** instruments. Write explicit **package lines** in the roadmap (e.g. "Privacy-by-Design Package = GDPR + AI Act + DSA/DMA + CRA + DEP safety pilots").
3. **Finance is Strategic.** Funding gaps were among the most frequently cited "hurdles." Connect EIC/InvestEU/EIT/ESIF/DIHs and DIHs with Angels/PE into a single EU pipeline for VW start-ups and integrators. Track funded firms, leveraged capital, exits, and EU infrastructure share.

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4. **Interoperability Wins Legitimacy.** Specify **conformance profiles** and **cross-platform pilots** (avatars, assets, identity, and data) using the 28th-regime sandbox language; measure vendor conformance and time-to-onboarding.
5. **Bring Makers to the Table.** Platform/tech-maker ownership was under-tagged; assign explicit **maker-led work-streams** for interoperability and AI-by-design patterns.
6. **Name Near-Term Milestones.** The board clusters around **by 2027** (first pilots/guidance), **2028–2030** (broad adoption), and **2031–2035** (sector scale-out). Use these three rungs consistently across pillars.

Reading the transcripts of the conversation that took place on top of the post-its filling and also during the plenary, we can add, for us to take these issues up and translate them into roadmap-relevant indications, the following comments:

- There is a need for EU "champions" (the massive ones being considered as "hyperscalers" by some of the participants). Interestingly, there was some disagreement on this topic, between rather pessimistic and more optimistic perspectives on the chance and channels to attain the right level of competitiveness for EU players[19].
- Many legal (mostly lagging) issues were mentioned, especially regarding mental health concerns (with virtual but also with mere augmented applications), as well as massive misinformation and cybersecurity problems. However, addictions and cyberbullying in VWs are not new, as they seem to prolong what already exists in social media and video games.
- There is a need for supporting the development of ethics-by-design sandboxes, to pre-test AI interactions in real-world conditions (this goes in the direction of the 2nd Policy Brief (see section 2).
- The pervasive development of generative AI in virtual worlds raises an IPR issue that is difficult to solve.
- In support of the Draghi report: there is a need for a more serious approach to capitalisation and ROI evaluation of XR/VW developments (not just experimental, creative and "nice to have" ones).
- There is a need to establish clear and convincing use cases for the use of XR in industrial applications. This aligns with direct feedback from industry leaders during our workshops, where a lack of clear and convincing use cases was identified as a primary barrier to progress in industrial virtual worlds.
- One proposal for metrics of a quantitative kind is the increase over time of: PoC applications, start-ups and scale-ups (another post mentioned the need for more unicorns), in any case, staging a progression that can only come from a combined support/endeavour of several instruments and stakeholders involved.
- Demand for reducing bureaucracy. Interesting but not easy to cope with.
- For the longer term: generally speaking, very low environmental concern regarding the impact of the digital and, in particular, of VWs' carbon and hydric footprints.

[19] One of the threats mentioned, with the example of Spotify, but we could have mentioned Minecraft, is that the European champions may leave. Let's see, for instance, what Mistral AI, mentioned in one post-it, will do depending on the evolution of the fiscal regime in France. We need to nurture framework conditions for European champions to emerge, but also keep them on board.

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- Participants tend to quickly forget about the strict EU definition of virtual worlds and seamlessly pack into one single topic XR and VWs, and integrate as part of the obvious discussions: autonomous vehicles, digital twins, robotic surgery and XR in the industry (like aviation, for instance). Now, this is an interesting topic: how to federate and capitalise on developments that have shown their PoC value and can help increase industrial literacy towards more effective, relevant and numerous XR/VW developments. We have addressed this issue in the context of healthcare in our workshop, OPENVERSE 2.3/1, in July 2024. It is undoubtedly a promising track, avoiding the creation of virtual worlds as a definitive, stabilised format and, conversely, opening up to fluid capacity adjustments.
- Participants seem to hesitate between those who see the development of virtual worlds, especially regarding how it is being deployed in Asia (more practical than regulatory), as a fragmented arena and those who ask for more stringent interoperability incentives, others, probably converging, asking for more open components and open source support.

4.3 MAKING THE MOST OF WORKSHOP 1 INPUTS

Building directly on the analysis in **Section 4.2**, which outlined the issues, stakeholders, and instruments surfaced through the three breakout exercises and the ensuing plenary, this subsection distils the contributions into a concise set of strategic takeaways. The intent is to translate a rich and heterogeneous body of inputs into a readable, decision-oriented narrative that bridges from “what was said” to “how it can inform the roadmap”.

1. **Trust as the foundation: adopt a blended policy mix.**

   Participants converged on the view that a trustworthy, safe and ethical environment is a **non-negotiable precursor** to both user uptake and builder investment. In practical terms, this suggests a blended policy approach: maintaining firm guardrails through a defensive regulation strand (e.g., GDPR, the AI Act) while, in parallel, deploying **promotional instruments** (regulatory sandboxes, targeted pilots, testbeds) that allow innovation to proceed within clearly defined boundaries. This dual-track operationalises Pillar A (Trust & Safety by Design) and Pillar B (Interoperability & Data-readiness) by coupling obligations with opportunities to experiment under supervision.

2. **Strategic finance and economic sovereignty must move in lockstep.**

   The workshop identified insufficient EU risk capital and fragmented financial pathways as structural barriers to business scale-up. A coherent **funding pipeline**, spanning EIC and InvestEU through to private equity, corporates and angel networks, and maybe even some additional options to consider, was seen as essential to mobilise deployments beyond pilots. Crucially, finance was framed as a sovereignty lever: nurturing European **“champions”** (including infrastructure providers) and strengthening value chains around AI, chips, cloud and immersive tooling to reduce strategic dependency and deter the talent and scale-up drain to extra-EU markets.

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3. **Interoperability is the route to legitimacy and scale.**

   Interoperability emerged as the technical and market backbone of a genuine progress to be envisaged in the **Single Digital Market** for virtual worlds. Participants called for a shift from abstract standards debates to **practical, demonstrable and also, if needed sectoral solutions**: (a) develop **conformance profiles** (clear, testable subsets of relevant standards), (b) run **cross-platform pilots**—notably for identity, avatars and digital assets—and (c) exploit an EU-level **"28th-regime" sandbox** to test legal and technical interoperability under real-world conditions. Despite hurdles the centrifugal force due to international competitiveness, progress here was regarded as decisive for SME participation, procurement readiness and international credibility, directly feeding **Pillar B**.

4. **Empower creators and build a coherent and yet diversified skills pipeline.**

   While policymakers, researchers and corporates have clear roles, the workshop noted that makers, developers, designers, and creators are often underrepresented in governance and standardisation work. The roadmap should therefore establish **maker-led workstreams** (e.g., for innovative cross-services, but also AI-by-design safety patterns and interoperability artefacts), alongside a **skills pipeline** that attracts, trains and, critically, **retains** creative and technical talent. This implies aligning education, micro-credentials, mobility schemes and incentives with real testbeds and procurement channels, reinforcing **Pillar C (Skills, Tools & SME Scale-up)** and **Pillar D (Science–Industry Testbeds & Sector Adoption)**.

5. **A phased timeline provides structure for action and measurement.**

   Contributions coalesced around a pragmatic three-phase arc, which also supports the definition of milestones and KPIs:

   - **Near term (to 2027):** stand up initial pilots; publish implementation guidance; activate targeted regulatory sandboxes and early conformance testing.
   - **Mid-term (2028–2033):** drive broader adoption of harmonised profiles and reference implementations; extend and consolidate funding pipelines as well as joint undertakings; expand cross-border testbeds.
   - **Long term (2033–2035 and beyond):** achieve sectoral scale-out (e.g., health, manufacturing, cities, culture, security) on mature testbeds, with an **interoperable, trust-anchored** ecosystem and measurable economic impact.

   This phasing underpins monitoring in **Pillar E (Foresight-in-the-Loop & Policy Operations)** and ensures continuity from experimentation to adoption.

6. **Monitor emerging tensions proactively, especially IPR and sustainability.**

   Two cross-cutting challenges require early, continuous attention within the roadmap's foresight and risk functions. First, **IPR in the age of Generative AI**, encompassing provenance, authorship, licensing, and reuse in immersive contexts and virtual assets, was perceived as unresolved under current frameworks and a likely brake on professionalisation if left unclear. Secondly, **environmental sustainability**, particularly in terms of energy and water use across computers, networks, and devices, received less emphasis than warranted. The roadmap

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should therefore embed **explicit environmental metrics and targets** (e.g., energy intensity per active user hour, low-impact reference architectures) to remain aligned with wider EU climate policy and investment criteria.

Together, these six takeaways convert the workshop's breadth of insights into a focused implementation spine: anchor trust, finance for sovereignty, prove interoperability in practice, put makers and skills at the centre, phase actions with measurable waypoints, and keep IPR and sustainability under constant review, thus providing a clear bridge from the analytical outputs of **Section 4.2** to the action-oriented proposals developed in the following **Section 5** of this deliverable.

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5. THE OPENVERSE ROADMAP V1.0

5.1 TRANSLATING INSIGHTS INTO ACTIONABLE MEANS

The purpose of this section is to make good use of all previous inputs to set out a roadmap proposal.

First, we assume that the goal has not changed. It was set in 2023, enriched by a few ideas along the way. Still, it has remained compact and valid to date, and unless something extremely unexpected changes the course of expectations, it will remain so until the end of the OPENVERSE project. That does not mean it is intangible. There are pending issues that we will have to consider. The world has changed a lot since July 2022, yet we will stick with our assigned mission as having a non-negotiable goal. Any revision of the goal is the responsibility of EU policymakers, who should monitor developments and update it as required. We are only supposed to make suggestions on how to boost our deck and help the EU, with its well defined goal, not only to attempt at attaining it, but also, in the meantime, to compete at the broadest international level thanks to the excellence that is being produced in the EU, while maintaining the set of values that we associate with good citizenship.

Having said that, the methodology that is being deployed is to start with the goal as defined in 2023, meaning the ten action lines proposed as supportive means for the target objective, and see in this recall, whether, based on our own constructive work and acquired knowledge, we can identify either: 1) need for updates that would be necessary for these lines of action and 2) new actions to be proposed.

To proceed, we need to go backwards in time and operations, from the goal to what is necessary to reach it — i.e., the actions that will get us closer to it — and then, eventually, to the building steps for these target actions.

The next operation follows the same back-casting move: from the goal to the needed actions, then from the required actions to the steps that make them possible and actionable.

These steps, which have been theoretically discussed in the previous sections, will need to become concrete, credible progress possibilities for enabling the target actions. This will be done in two phases:

- A first one encompassing the inventory of steps for five critical categories of concern (technologies, products/applications, markets, capabilities and regulations/support measures in chain-like visuals following a loose timeline projection.
- A second one, examining key possible linkages and conditions between the steps and the progression chains they may constitute, with some possible time-relevant checkpoints, although this last aspect may be further enhanced in subsequent versions of the roadmap.

Finally, with these steps in hand and what they encompass (areas of deployment, stakeholders), we will wrap up these inputs to sketch out the roadmap.

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5.2 KEY KNOWLEDGE OPERATIONS FOR THE ROADMAP

Let's start with the goal and go back to the inventory of actions that were interestingly proposed to support the EU strategy regarding virtual worlds and the Web4.0 in July 2023.

5.2.1 Updating the 10 Key Actions of the 2023 EU Proposal

Along with the goal, its associated pillars, and sub-objectives, published July 11, 2023, and examined in sections 3.1.2/3.1.3 of this Deliverable, we can identify ten recommended actions worth pursuing in support of the strategic objective. We have commented on them to either update, suppress, or combine them with today's criteria, before envisaging, still in the light of the current context, the missing actions:

Table 3: The initial strategy (July 2023) and how it compares with today' situation (2026)

Actions advocated in 2023		**Status today (end of October 2025)**
• Action 1: Build skills for virtual world technologies through Digital Europe; the EU as an attractive destination for highly skilled non-EU talent.		No change, still the same goal.
• Action 2: Promote guiding principles for virtual worlds, research on health and well-being impacts, including children, via HE.		Mental health is a significant problem, with various causes, including virtuality and screen time, although XR is considered a promising treatment channel.
• Action 3: Create a Virtual Worlds Toolbox for the general public and youth under the Better Internet for Kids strategy		Difficult to see this happen, instead we would advocate for the development of multiple virtual worlds and tools, education to use them (virtual world literacy)
• Action 4: With MS, consider launching a European Partnership to develop an industrial/technological roadmap		The Partnership is emerging in 2025 (SRIA, with Siemens as the pilot), but others with diverse specialities can be developed, and a roadmap is possible.
• Action 5: Help EU Cultural and Creative Industries test new business models in virtual worlds through Creative Europe, with matchmaking between developers and industrial users, through EDIHs and EEN to support hubs and uptakes		Exploring creativity and innovation beyond formal IPR is a goal, and leveraging existing hubs and networks is a strength to build on.
• Action 6: Develop standards for open/interoperable virtual worlds; explore digital cooperation models; build a toolbox to combat counterfeiting in virtual worlds; promote regulatory sandboxes for virtual worlds by MS.		Several goals have been mentioned so far, with inconsistent results. Progress is still lagging.
• Action 7: Support flagship projects for smart/sustainable cities (CitiVerse) and the European Virtual Human Twin under HE/Digital Europe; encourage European Digital Infrastructure Consortia (EDICs) in Web 4.0-related areas.		Partial successes on their way (cities = strong players), with diverse, like-minded and connected options possibly taking the relay.
• Action 8: Create a platform for MS to share approaches and best practices on virtual worlds and the broader Web 4.0 transition via an expert group		From EU programmes/projects or MS pioneering actions, several initiatives are emerging that need to be supported and strengthened.
• Action 9: Engage with multi-stakeholder internet governance bodies to design open/interoperable virtual worlds		While several initiatives and coalitions are moving in that direction, whether for general or sectoral purposes, progress is still lagging.
• Action 10: Implement a structured, collaborative approach to monitor virtual worlds' development across sectors with MS and stakeholders.		Several currently deployed EU-funded projects could contribute to that goal.

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This comparison and contemporary appraisal are meaningful and show that, although many of the 2023 initiatives remain valid, we need to consider significant updates, including improvements, combinations, and new proposals (missing from the 2023 action list). This assessment goes as follows:

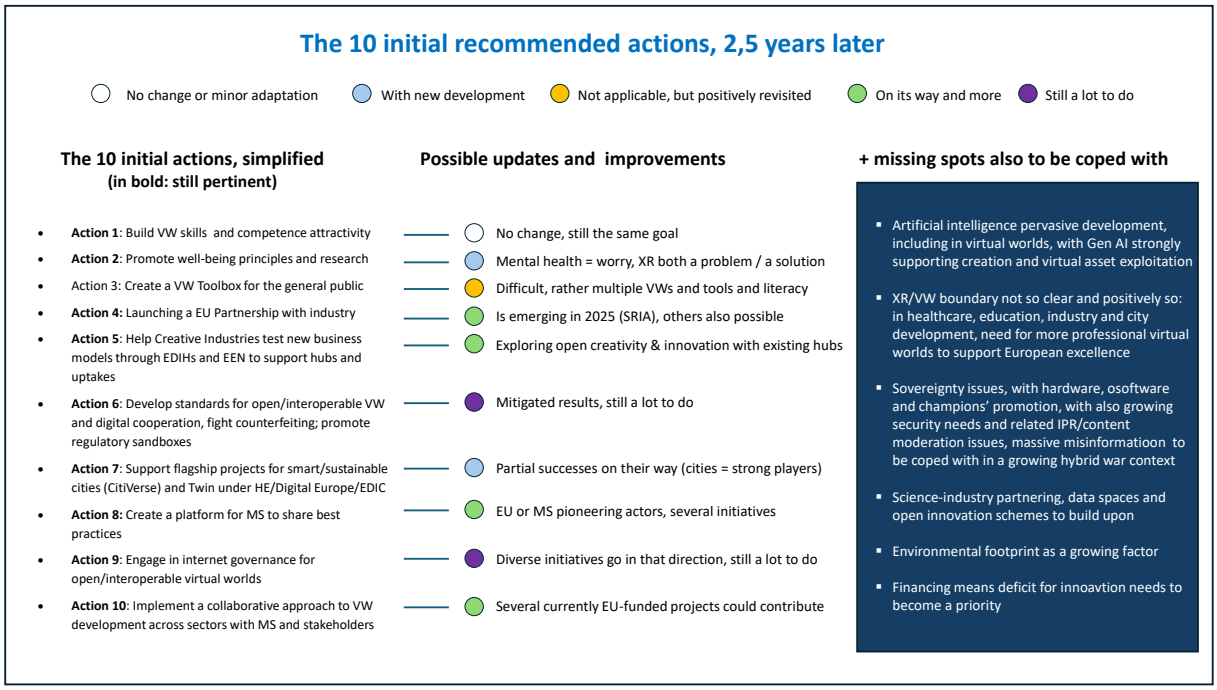

Fig 9: How to appraise the 2023 recommended actions for today's needs

5.2.2 The Key Steps to Consider for the Action Phase

Now, to get action-ready, some steps are necessary. While some of them are already engaged, to be continued and perhaps strengthened, others are to be envisaged for a future yet to come.

This step-by-step part of the roadmap will be outlined in two phases: the first showing the channels for integrating resources, capacities, and metrics needed, and the second dedicated to examining key connections across the board.

Let's see how the engagement of the different components (encompassing a mix of actors and factors) can be staged:

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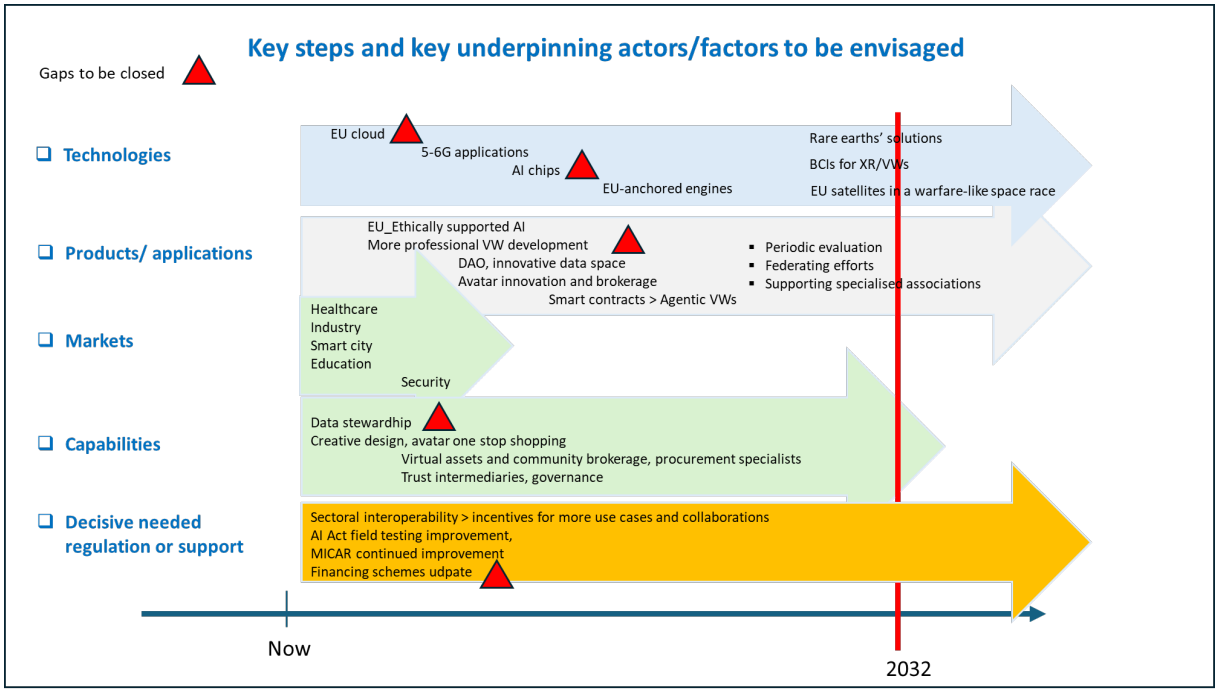

Fig. 10: The most obvious steps for a first outline that can lead to progression towards the goal

Needless to insist too much on the fact that the above proposal is not comprehensive but mainly indicative and meant to be eventually stimulating a discussion within our emerging expert community, including some possible interesting deep dives (see for that the concluding section).

5.3 THE OPENVERSE ROADMAP V1.0

From all the preparatory work, presented or summarised, we can generate **a roadmap** which can be put online to be discussed within our expert community and perhaps beyond, for some deep dives, refinements and updates, if needed, in view of preparing for next year's workshop (Sept. 2028) in the best conditions.

The previous section led us to propose our own list of key actions, also 10 in all, even if considerably enhanced from the 2023 starting point, in the middle of two constraints, on the one hand, the summary of all the preparatory work detailed in the first sections of this Deliverable and, on the other hand, the goal for virtual worlds and the Web4.0 set by the EU in July 2023.

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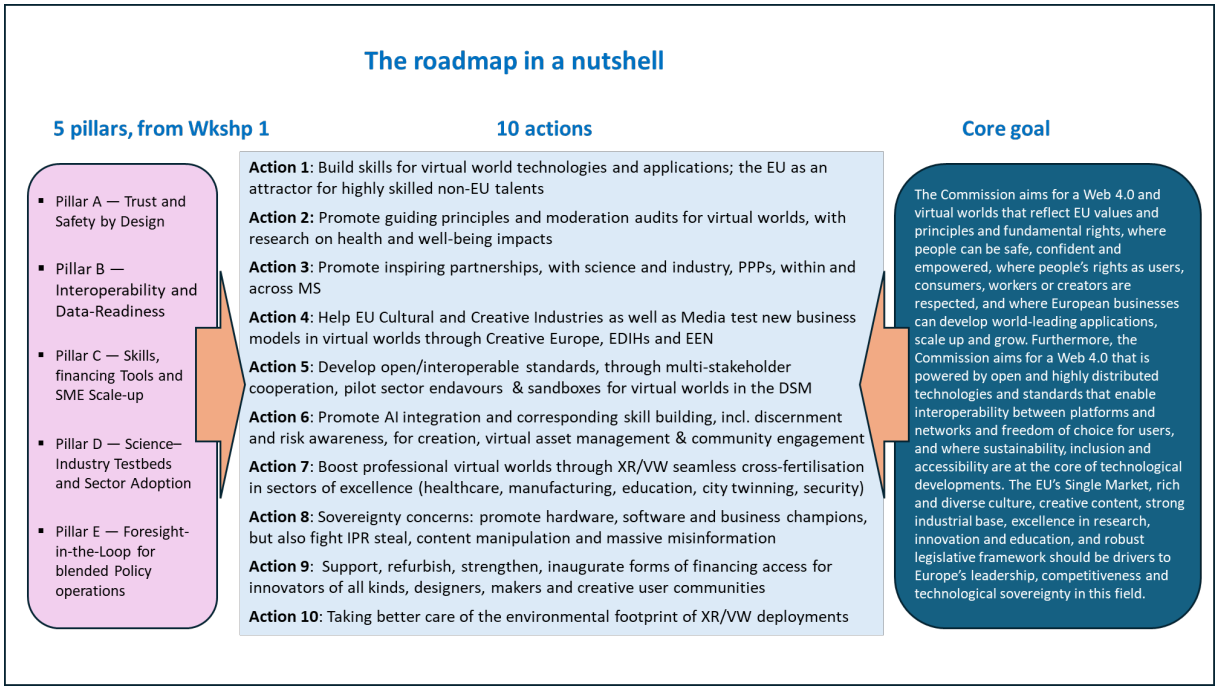

Fig. 11: The roadmap actions in a nutshell

Now, connecting the 10 actions with the steps of Fig.11 and what they represent in terms of **actors and factors** to align to generate progression, we can outline the following roadmap:

Table 4: The OPENVERSE Roadmap v1.0 (actions, impacts, actors and time)

Key Actions (short format)[20]	**Expected impacts**	**Lead and partners**	**Target Time**[21]
KA1: Build skills for VWs, the EU as a talents' attractor.	Substantial increase in the number of individuals capable of becoming makers, creators, brokers, counsellors, evaluators, and researchers, with significant results in the number and originality of applications for all key sectors.	EU P-makers, industry, research, MS, specific sectors (health, security).	2026-2032
KA2: Promote guiding ethical and health principles for well-being in VWs.	Documented research on mental health and related risks, with medical and legal reference increase, protection implemented and more systematically enforced, in parallel with privacy and trust increase.	EU P-makers, research, health sector, legal sector, users' communities, education, media sector.	2026-28
KA3: Promote inspiring partnerships across sectors and boundaries.	New applications, markets, and business models should accompany the increase in numbers (users, virtual assets, communities, research output, IPTR evidence, etc.).	EU P-makers, Industry, research, health, cities, MS, financing means, XR/VW assoc.	2026-2028

[20] For the full wording, see Fig. 12 «The roadmap in a nutshell».

[21] Let's observe that there are only three different time regimes suggested here: 1) immediate and short-term engagement, for urgent results (2026-2028), 2) medium-term effects to be expected but implying to start immediately regarding actionable measures (2026-2030) and 3) longer-term effects to be expected for issues likely to stay for some time and requiring particularly tenacious efforts (2026-2035).

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KA4: Help the EU Cultural & Creative Industries and Media sector test new business models.	Creators as individuals through communities deploying a large bandwidth and scalable professional output, with or without AI, but also new business models should build on PPPs, BC-related communities and open innovation schemes as much as on classical IPR.	EU & MS, Media and culture sectors, education, financing means, XR/VW assoc., business schools.	2026-2030
KA5: Develop standards for open/interoperable virtual worlds, with sandbox options.	At least some sector progression should become measurable, and cross-use of virtual assets should become increasingly common and referenced. Pilot incentives and actions valuing XR/VW associations supported and capable of scaling.	Technology makers, industry, users' communities, XR/VW assoc.	2026-2030
KA6: Promote AI integration and corresponding skill building for VW creativity.	Upskilling of various kinds, data stewardship, ethical specialists, procurement experts, but also asset managers and brokers, AI creation advisors, avatar librarians, etc., should emerge in numbers.	EU P-makers, research, technology makers, designers, education, industry champions, security specialists.	2026-2028
KA7: Boost professional virtual worlds through XR/VW across sectors of excellence.	Healthcare, security, industry and city management should at least reach measurable performance and shareable experience, definitely going beyond the interesting but dispersed experiments as we know it, i.e. towards professional ROI.	Industry, technology makers, designers, XR/VW assoc., education, EU P-makers & MS, financing means.	2026-2032
KA8: Sovereignty concerns: promote champions, and fight IPR theft, content manipulation and misinformation.	The journey is still long, but we must start somewhere. Cloud issues, chips, AI, and XR/VW makers, and small champions should be encouraged with absolute priority. Misinformation, deepfakes and alternate reality narratives are challenging to fight, but new means are emerging. AI seems to represent both the problem and its solution.	EU P-makers & MS, industry, financing, legal sector, defence and security, media sector, education.	2026-2035
KA9: Support, strengthen and inaugurate new forms of financing for VW creators.	What exists is too little known or used, but new means must also be created (some are close to launch, others still in the waiting room) to create the stimulating environment that lags so much behind our competitors. Evidence of easier access and of new financing schemes should quickly have its own metrics.	EU P-makers & MS, financing org., business schools, designers and makers.	2026-2028
KA10: Taking better care of the environmental footprint of XR/VW deployments.	So far, the environment has been mishandled (valuing distant collaboration) or not handled at all, but the digital rise is such that VWs are part of the pack, and the moment will come when there will be a price to pay. Preparing for that can bring some benefits.	EU P-makers & MS, environmental specialists, energy sector, education, research.	2026-2035

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6. CONCLUSION

6.1 PENDING ISSUES AND KEY SYNERGIES TO WORK UPON

The roadmap will be submitted to our community of experts, discussed, improved, and updated, and some pending issues will necessarily cross the board. Let's mention in particular:

- Interoperability progress in a highly competitive and proprietary-oriented market.
- Which actors are behind progress in technological standards and international collaboration?
- Immersive environments and blurred lines between real and virtual, and the long-term effect on cognition and mental health.
- AI future and how the EU will struggle in the middle of giants.
- When will the environmental footprint exceed the benefits of distant collaborations facilitated by XR/VWs? How will brain-computer interfaces fit in virtual worlds tomorrow?
- Is open source such a magical pencil? Several European projects changed their minds after evaluating their limits in maintaining them after the end of subsidies. We are all strong believers in open source, but a new generation of support schemes may be needed, especially to help open-source component makers cross their "Death Valley"[22].

These are only a few essential questions we will have to continue tackling and, if possible, cope with, and throughout keep a learning attitude.

To progress, we can work on the intermediate conditions of how the roadmap can help virtual worlds and the Web4.0 to make quick progress, by not only stating how the technologies, products, markets, capabilities and EU regulation and stimulation instruments should be deployed, as specific tracks, but also how they can be connected and build effective synergies. Studying these linkages is a typical deep dive that, at some point, will be explored and translated into actionable results in OPENVERSE or other related European or MS research projects. Below follows a display encompassing four such examples.

[22] In fact, one of our participants provided a detailed comment, adding to the already critical observation made by one of our experts and reported here above. This second comment is almost ethnographic and deserves to be examined with great attention: "*Open-sourcing results from EU-funded projects is often encouraged in principle but fraught with practical challenges. Under EU grant rules, if project outcomes generate commercial profit within about three years, beneficiaries may be required to repay part of the funding or share revenues. When results are released as open-source software, it becomes nearly impossible to trace who profits from derived products, creating legal uncertainty over whether repayment clauses apply. For large companies, this ambiguity represents a governance and audit risk: if open-sourcing later triggers a payback obligation, it could be seen as financial mismanagement. Consequently, corporate finance and legal teams often oppose open-sourcing EU-funded work. These concerns lead to risk aversion, discouraging open collaboration and pushing firms to keep outputs proprietary, even when openness would better serve innovation and the broader XR community."* When we say "Open", open innovation is almost obvious, open source a bit less requiring a more cautious approach.

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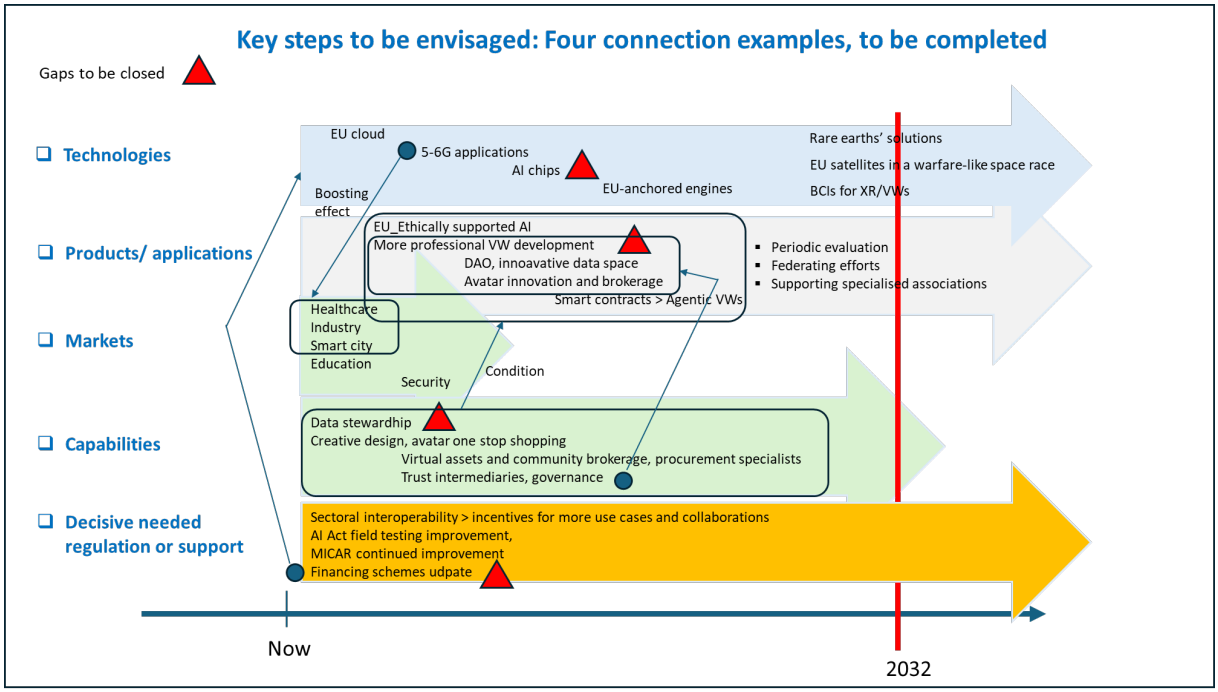

Fig. 12: Initiating a "connecting the dots" work with four examples

The four examples suggested here should be detailed in a way that allows the more closely involved stakeholders to contribute and advance progress, with clear metrics. This is for the next stage, in which a list of 10-12 such linkages will need to be examined (with possible deep dives) and receive clearance from regulatory and industry perspectives. They can be supported by conditions such as evidence of progression, either quantitative or qualitative, stakeholder alliances as pre-emptive conditions and skills deployment, but also metrics that can help motivate business actors (investment level, time frame, ROI), and finer timelines (with deadlines and/or fixed urgencies, even if some of the progressions envisaged in this last section may take more time).

6.2 AN ONLINE PLATFORM TO CONTINUE ENHANCING THE ROADMAP

Part of the process that we have designed and implemented, as well as explained in Fig.8 /section 4.1, consists of considering that Workshop 1 of Oct. 16, 2025, was a preparatory step and that the roadmap proposal of the previous section should be accessible online for discussions and improvements until the final workshop, foreseen in September 2026. This online availability will take place during the month of November 2025, and the technical modalities for who will actually establish and manage this access space are still under discussion at this time. Then, at some point, we will recompile an updated version to be presented and discussed, enhanced and/or validated in the final workshop.

The resulting roadmap will further become part of the OPENVERSE Observatory, occupying a prominent position to ensure its legacy as a living resource that can be nurtured and enhanced through continued stakeholder interaction far beyond the project's duration. This is in line with the strategy of Observatory-centred sustainability explained in the Annex I, section 1.6.2 .

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6.3 OUTLINING POLICY RECOMMENDATIONS

Now, to close the life cycle of this roadmap version, we need policy recommendations. In fact, all ten actions are recommendations. However, to make it more incisive, we can rely on the five pillars (acknowledging that our roadmapping process is, of course, not fully bijective, but "osmotic" from end goal to essential components and vice versa). Of course, in the further step of our roadmap's enhancement, we will be able to go further (or deeper) in terms of specifications and what we expect in terms of actionability and progress measurement.

As **first-level recommendations**, let's recall how the five pillars of our constructive work go about (but for complete reference for these pillars, see section 2.4):

Trust and Safety by Design. If people do not feel safe (in the sense of privacy and integrity protection) and secure (in the sense of cybersecurity), they will not stay; if builders lack clarity, they will not invest. However, if everyone is only concerned with preserving safety and trust conditions, innovation can be killed. The goal of this first pillar is to ensure that all these requirements remain aligned. The roadmap promotes visible safeguards, proportionate moderation and accessibility, with progress measured by concrete indicators (e.g. time-to-remedy, coverage of risk assessments). Eventually, the whole "Trust and safety by design" approach should also always be pondered by the need to avoid killing innovation, as a development-minded guardrail.

Interoperability and Data-Readiness. Interoperability is treated as plumbing. Priorities include identity and asset portability, usage control, and policy-enforcement signals, implemented through **conformance profiles**, plug-fests and open reference stacks aligned with European data-space approaches and emerging ISO/IEC guidance, also meaning that some sectors may play a pioneering role in terms of operability (healthcare, education, smart cities, industry).

Skills, Financing Tools and SME Scale-up. Europe cannot regulate its way to leadership; it must build and stimulate entrepreneurship as a mindset and as a career. The roadmap links creator toolchains and interoperable asset libraries to Digital Innovation Hubs and a coherent finance path (EIC, InvestEU, EIT, ESIF) while using public procurement to create first markets for interoperable, accessible solutions, as well as scalable options.

Science–Industry Testbeds, for stronger cohesion and enhanced Sector Adoption. To escape pilots-that-never-scale, demonstrators must be designed as value chains from the start. This roadmap proposes cross-border testbeds that link virtual worlds with data spaces and digital twins in sectors where Europe already has capability: health and care, manufacturing, cultural heritage, energy and cities. Higher Education and DEP calls finance the early nodes; ESIF and regional programmes help extend them; and standardisation bodies receive concrete inputs from what actually works. The pay-off is twofold: SMEs gain predictable routes to customers, and sectors gain shared language and reusable components.

Foresight-in-the-Loop. Regular scanning, tripwires and annual refreshes keep policy agile and cumulative, ensuring that lessons from concrete deployments feed back into sandboxes, standards' profiles and procurement guidance can be adjusted on evidence rather than intuition. However, foresight is not only about regulation, it should do more than foresee and follow-up, i.e. proactively recommend some decisive and even urgent in-roads, such as the support to European engines for

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gaming, or boost infrastructure for specific domains of applications, for instance in 5-6 G for health, smart cities and industry. In addition, foresight should also be dedicated to help people get out of their comfort zone, meaning for instance, for the European industry, using the future to enlarge its mindset and sense of experience regarding investment, risks, science-industry alliances, international collaborations, including with extra-European players, to gradually head to a more proactive capacity of deploying skills and excellence.

Going back to the Roadmap and more specifically to its **time frame**, we can also stress that time, in terms of recommendations, plays a dynamic role: on the one hand, policy-makers should have clear suggestions of how each action should ideally unfold, but also have the leeway to conceive how several actions, in particular those which are meant to handle stakes that are there to stay for a while, need to build on a period rather than from a deadline, even though some checkpoints can be envisaged along the way. This is why we suggested three different time regimes:

1) Immediate and short-term engagement for urgent results (2026-2028), meaning: urgency, but also using existing instruments to reach measurable results in this time frame.

2) Medium-term effects to be expected, but implying to start immediately regarding the actionable measures (2026-2030), fitting problems that are of more complex handling than specific urgencies.

3) Longer-term effects to be expected for issues likely to stay for some time and requiring particularly tenacious efforts (2026-2035), with two kinds of problems to be tackled, mainly, 1) the environmental problem, which will gradually come into play as an arbitration component in decision-making and, 2) the interoperability requirement, which is much needed and already traceable in some interesting accomplishments (general purpose, sectoral or niche ones), but also subject to centrifugal forces due to the international economic and commercial competition, which virtual worlds are involved in, with proprietary-minded inclinations continuously being revived.

Finally, let's stress that some of the actions we recommend for immediate or medium/longer-term attention are already being tackled, and with some successes to build upon, another task for further discussions, to make sure not to forget and value existing engagements going into the directions we recommend.

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ANNEX I: SUMMARY OF RESULTS FROM OPENVERSE TASKS

(This annex is summarised in Section 2 of the Deliverable)

1. OPENVERSE CONTRIBUTIONS FITTING THE ROADMAP REQUIREMENTS

1.1 INTRODUCTION: PURPOSE, EVIDENCE BASE AND STRATEGIC CONTEXT

This section integrates contributions from multiple work strands[23]:

- **Platform assessment and co-creation readiness.** A consortium-validated analytical framework screened 118 environments to 22 with co-creation potential and a shortlist of eight for hands-on experimentation and user involvement, emphasising accessibility, identity, interoperability, ethics, and sustainability.
- **Trends, adoption and use cases.** Market and technology analysis identifies strong near-term traction (e.g. training, customer experience, collaborative design) and structural barriers (skills, integration, standards), guiding priorities for policy intervention.
- **Ethical-legal and governance frameworks.** A six-pillar framework (privacy/data, identity/anonymity, inclusion/accessibility, moderation, AI transparency, legal interoperability) supported by an AI-assisted knowledge graph informs guardrails and benchmarks.
- **User-level experimental evidence.** Controlled studies on rule frameworks and identity signalling show that proportionate, visible safeguards increase perceived trust and reduce discomfort without diminishing openness, whereas strict real-identity cues may depress immersion with limited trust gains.
- **Standards landscaping and liaisons.** Mapping across ITU, ISO/IEC, IEC, W3C, IETF and 3GPP, leveraging the VDE XR/Metaverse register and a new StandICT.eu working group, identifies priority gaps (identity/asset portability, usage control and moderation, safety and provenance signals, commonly agreed upon resources for data trustworthiness), urgently to be worked upon.
- **Data spaces and trusted data exchange.** The IDSA-aligned model, in line with GDPR, the EU Data Act and the Data Governance Act (DGA), offers sovereign, auditable, policy-constrained data sharing foundational to cross-platform interoperability.
- **Stakeholder ecosystem and Observatory operations.** The Observatory's taxonomy-based aggregation (companies, platforms, standards, projects, national initiatives, funding) and marketplace growth support evidence-based policy and community alignment.

[23] Some 12 different OPENVERSE tasks were summarised, half of them achieved at mid-project, the other half being work in progress but well defined enough to contribute. In the final version of this Deliverable (at month 34), an updating work of this collective input will be carried out.

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- **Exploitation and sustainability.** A living catalogue of results, cases, business-model support and periodic market scans tie exploitation plans to demand signals and long-term maintenance workflows.
- **Cross-initiative synergies.** Re-use of XR4HUMAN assets (Code of Conduct, Interoperability Guide, Experience Library, Regulatory Gap Analysis) strengthens openness and continuity through XR4Europe custodianship, along with a diversity of converging European projects.
- **An anticipatory exploration** for a two-time horizon perspective (technological foresight, in the large sense), which will be presented in the next section.

Taking stock of the conjunct knowledge underpinnings of these different contributions, we can assert that the European vision for virtual worlds must be grounded in openness, inclusion, safety and digital sovereignty, balancing global interoperability with autonomy concerning critical capabilities, yet with the urgent need to contribute to the industrial development of the European economies. Data-space architectures now reaching a reasonable level of standardisation maturity (e.g. Dataspace Protocol; ISO/IEC 20151 at Draft International Standard stage), provide a practical substrate for GDPR-compliant, FRAND-aligned data mobility and control (for Fair, Reasonable, And Non-Discriminatory), under the Data Act, and trusted intermediation under the Data Governance Act (DGA)[24]. In parallel, standardisation pathways across the Internet, web and network stacks require coordinated European inputs to embed human-centric requirements (identity portability with privacy, usage control and auditability, content provenance and amendability) into deployable profiles that lower integration costs for SMEs and public administrations. This threshold of requirements and expectations is meant to nurture the industrial needs which virtual worlds are increasingly capable of contributing to, including with corresponding IPR and taking up financial access challenges[25].

1.2 TECHNOLOGICAL FOUNDATIONS AND ECOSYSTEM DYNAMICS

1.2.1 Virtual World Platforms: State of Play and Assessment

Europe's virtual world landscape seems to be maturing quickly. Yet, OPENVERSE partners had to tackle this appraisal with rigour and methodological dedication, examining a large array of platforms, areas of applications, technologies, and market adoption. To start with, OPENVERSE partners completed a systematic assessment of the current platform landscape to identify environments with strong co-creation potential. An analytical framework validated through consortium workshops rates platforms across 10 key dimensions, including accessibility and inclusion, identity, interaction, co-creation,

[24] It will be one of the duties of the roadmapping process to identify gaps that are still hampering the overarching goal of the EU for virtual worlds and the Web4.0, and which can be favourably addressed in that domain in the coming years.

[25] This is another one of the duties of the roadmapping process: identifying in detail and with possible progression steps which have to be defined and measured regarding the financing needs of small and bigger players of the virtual world arena.

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immersion, creator economy, interoperability, trust and security, ethics, and sustainability[26], and also checking how these virtual worlds were inserted and functional in some 24 domains of application. From an initial long list of 118 examined virtual environments, 75 met baseline criteria. The list was later refined to 30 conveying promising co-creation potential, which went through a deep-dive assessment (involving the Analytical Framework of 10 dimensions and 29 sub-dimensions), to finally lead to a short list mix of eight platforms suitable for hands-on experimentation and methodology piloting. The targeted purposes span creating, working, learning, socialising, transactions, entertainment and service exploitation, mapping directly to user and market value propositions. This evidence base, in addition to serving as a first deep familiarisation step with immersion qualities, but also within broad economic and geo-political considerations, underpins the design of co-creation calls and workshops and informs subsequent policy discussion on where public action may catalyse European strengths in human-centric virtual worlds. In particular, this early analysis emphasised how the mainstream deployment of virtual worlds is attracted by entertainment needs and what kind of European strengths, in the service and industry sectors, should be more systematically explored and implemented.

1.2.2 Trends, Adoption and Use Cases in Europe

Market and technology analysis indicates a rapid maturation of immersive platforms in Europe (XR and virtual worlds combined), with most surveyed organisations (with dedicated decision-makers and experts' interviews) either using or planning some adoption in the near term. Leading use cases include immersive training, customer experience, collaborative service and product development, and, in the medium term, large-scale events and virtual meetings. Foundational technologies (XR hardware, 5G connectivity, digital twins, AI, including generative AI, IoT, and distributed ledgers) are converging to move many solutions from pilots to production. Persistent barriers remain, however: device comfort, network latency, skills shortages in technology mastery and content creation, integration with legacy systems, and the absence of widely accepted standards and governance models. These findings support a policy emphasis on interoperability (still an important gap in which we will have to come back in detail), skill pipelines and a highly competitive talent market at the international level, and coordinated standards work to lower adoption risk, and incentivising programmes to increase cross-sector collaborations and entrepreneurship motivation.

1.2.3 Data Infrastructure and Interoperability Enablers

Data spaces emerge as a stimulating enabler of trustworthy, interoperable virtual worlds. Building on the IDSA Reference Architecture Model, data spaces can enhance sovereign-sensitive, controlled sharing of data across many-to-many participants without centralising assets. This aligns with

[26] These 10 dimensions proposed to analyse the virtual worlds comprised in reality 29 sub-dimensions which were used for the analysis of the 30 virtual worlds, having to lead to a final concretely usable short list. For instance, the immersive dimension was broken down into sensorial, storytelling and challenge-related sub-dimensions. While the passing from the 75 well-documented virtual worlds to 30 was merely an elimination game of those not fulfilling certain essential criteria, the analysis of the 30 remaining virtual worlds was indeed a real deep-dive endeavour to select the most suitable applications for further OPENVERSE co-creation tasks.

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European norms (GDPR) and with the EU Data Act's phased obligations from September 2025, including fair, reasonable and non-discriminatory [FRAND]-based data sharing) and the Data Governance Act's provisions for trusted data intermediaries. For virtual worlds and digital twins, this approach addresses core needs, like identity and access control, usage-restricted data exchange, traceability and auditability, while supporting cross-platform portability of assets (e.g. avatars, ownership records, and preferences). Ongoing standardisation, including the Dataspace Protocol and the emerging ISO/IEC 20151 (DIS), among other similar contributing endeavours, offers a pathway for stable, internationally recognisable interoperability.

1.3 ETHICAL, LEGAL AND GOVERNANCE REQUIREMENTS

1.3.1 Ethics-by-Design Framework

OPENVERSE partners have assembled a foresight-informed ethics and legal framework anchored in six pillars: (1) privacy and data governance; (2) identity and anonymity; (3) inclusivity and accessibility; (4) content moderation; (5) transparency of AI-driven decisions; and (6) legal interoperability for cross-border operations. This is supported by an AI-assisted "Graph-RAG" knowledge system that maps entities and relationships across policy texts, legal frameworks and socio-technical literature, providing coherent answers to cross-cutting governance questions and reducing fragmentation in guidance to designers and operators. The framework is being validated through expert workshops and will feed practical benchmarks and checklists into subsequent governance and standardisation work.

1.3.2 IPR and Governance Models

Evidence from interviews with SMEs, policy-makers and industry experts, complemented by global policy scanning, informs candidate IPR and governance models that balance openness, decentralisation and protection of rights. Assessment dimensions include protection strength, enforcement, innovation incentives (including open innovation), economic impact and trust/stability. Emphasis is placed on simplified digital asset management for creators and SMEs within interoperable ecosystems, clarifying ownership and licensing while minimising transactional friction. These models are being iterated via multi-stakeholder workshops and aligned to European values and industrial priorities within the Digital Single Market framework.

1.3.3 Insights from Experimental Research on Trust, Identity and Safety

A controlled study with 101 participants across two prominent social Virtual Reality platforms examined how rule frameworks (platform self-regulation versus cues of external/public oversight) and identity policies (verified identity versus anonymity) affect perceived trust, privacy, openness, immersion and comfort. Three insights stand out:

- Visible, light-touch "external rules" increased perceived trust/safety and reduced simulator sickness without dampening perceived openness.
- Verified identity, in this setting, did not increase trust or openness and reduced immersion compared with pseudonymity.

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- Trust correlated positively with openness and negatively with sickness; immersion correlated negatively with trust and positively with sickness.

For policy-making needs, this suggests prioritising proportionate, legible safeguards and accountability mechanisms that preserve user experience and inclusion, rather than defaulting to stringent real-identity regimes.

1.4 TOWARDS A ROADMAP

1.4.1 Mapping and Gap Analysis

A coordinated approach to standards is underway, liaising with international bodies (ITU, ISO/IEC, IEC), the web and Internet stack (W3C, IETF), and telecom specifications (3GPP). The work draws on community assets such as the VDE XR/Metaverse Standards Register (~1,600 entries) and is being operationalised through a Technical Working Group established with StandICT.eu to curate these deployments, a key strategic way to watch, synthesise and prioritise inputs for the European context. Even if diversity and competitiveness in the standardisation arena is still the dominant pattern, internationally speaking, OPENVERSE results from foresight, ethics/legal and governance tasks are being used to identify main gaps and requirements, ensuring that standard efforts reflect human-centric principles, EU regulatory alignment and industrial feasibility. The findings will feed both the roadmap and downstream recommendations for standards participation and liaisons.

1.4.2 Priorities for a European Standards Strategy

Preliminary priorities indicated by partners include:

- **Human-centric interoperability progress**: identity portability, consented data portability and usage control across platforms, even if not yet mainstream, may be isignificantly improved upon.
- **Safety, trust and integrity**: content moderation signals, provenance and authenticity, algorithmic transparency hooks must be mitigated with due audits and enforcement, as already deploying.
- **Technology standards:** made better known, understood, tested and taken up by the variety of European makers.
- **Data space integration**: alignment with Dataspace Protocol and relevant ISO/IEC efforts to ensure discoverability, policy-constrained exchange and audit trails.
- **Open source**: Open source is not a magic formula but a compatibility journey between implementations and certain standard profiles to support European digital autonomy while enabling global interoperability.
- **Sovereignty:** no standard can be strictly (and only) European, outside of regulatory measures as they are being deployed, but which in their own terms force certain standards progress faster than others.

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1.5 STAKEHOLDER ECOSYSTEM AND STRATEGIC ALLIANCES

1.5.1 Ecosystem Mapping and Community Building

OPENVERSE has established an Observatory that aggregates heterogeneous content and reference types, including companies and SMEs, platforms, general purpose as well as virtual world technologies, standards, projects, national initiatives, funding opportunities and case studies. These diverse entities are indexed via a shared taxonomy and complemented by interactive analytics. The Marketplace of Opportunities has grown from an MVP to nearly 250 entries, while national initiatives (updated bimonthly) and engagement with over 70 EU-funded projects expand the evidence base and collaborative potential of the Observatory as an attractor. Co-creation workshops with producers, decision-makers, researchers and consumers are meant to explore and then, upon findings and lessons learnt, increasingly ensure requirements reflect real-world needs, demand-side and community potential across the EU and help surface policy-relevant gaps to be effectively addressed (e.g., vertical alignment between local initiatives and EU-wide strategies).

1.5.2 Synergies with Complementary CSAs and Initiatives

XR4HUMAN outputs, which consist in an XR Code of Conduct, an Interoperability Guide, an Experience Library and a Regulatory Gap Analysis, are directly reusable within OPENVERSE engagement and co-creation activities, itself supported by a large-scale design tool stimulation, in relation with creative usages of virtual worlds. XR4Europe's role as advisor and custodian helps ensure continuity beyond project development and timelines. Strategic representation at XR4HUMAN's close-out events and ongoing hosting of assets increases visibility, reuse or adaptation, with policy traction across communities and directorates, opening the way for more transversal collaborations.

1.6 PATHWAYS TO EXPLOITATION AND SUSTAINABILITY

1.6.1 Exploitable Results and Business Models

Through the Observatory, a living catalogue is being assembled to register project results, ownership schemes, terms of use and locations, forming the basis for partner-level and joint exploitation planning. Method support includes value chain analysis, business model design and IPR clarifications, with a variety of suggestions to reduce uncertainty for SMEs, start-ups, independent creators and public adopters in the context of the Digital Single Market as a strong business-supportive perspective. The market-watch component (delivered in cycles, with public webinars and other OPENVERSE task collaborations) provides up-to-date signals on value pools, vertical opportunities and technology readiness, tightly linking exploitation choices to demand-side realities.

1.6.2 Observatory-Centred Sustainability

To secure persistence beyond project end, the Observatory has role-based workflows for ingestion, moderation and maintenance; curated expansion of content types; and facilities for external contributions (e.g. sister projects, alliances, innovative initiatives). Version control, moderation layers and automated alerts preserve quality while enabling growth. The taxonomy remains the backbone

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for cross-referencing outputs (e.g. technologies, standards, ethics) with actors and assets, making the Observatory a long-term, low-friction gateway for European stakeholders in the virtual world arena.

It also belongs to the Observatory to facilitate the integration of a variety of proposals, projects, company assets showing how virtual worlds can go beyond the gaming tradition and contribute in their own terms to the Digital Single Market building and the EU service and industry rationale that it aims at supporting.

1.7 STRATEGIC RECOMMENDATIONS FOR POLICY DIALOGUE

The following propositions synthesise the above-mentioned contributions into candidate axes for the expert workshops of OPENVERSE Task 2.5. They are framed to invite prioritisation, timing and assignment of responsibilities, and can be translated into an effectively phased roadmap.

1.7.1 Promotion of Interoperability and Data Exploitation Readiness

1) Promote the adoption of data exploitation provisions (not only defensive, but also proactive) and data-space-compatible interfaces (identity, consent, usage control, logging), aligned with the Dataspace Protocol and forthcoming ISO/IEC guidance; encourage pilots that bridge virtual worlds and digital twin data ecosystems in priority sectors (health, energy, manufacturing, smart cities), to exemplify areas of European excellence.

2) Support open reference implementations and interoperable testing regimes to reduce integration risks for SMEs and public bodies (see also for that the Sandboxing concept promoted by the Policy Briefs).

1.7.2 Human-centric Safety, Identity and Trust

3) Prioritise proportionate, visible safeguards (moderation standards, amendability, provenance signalling) over blanket real-identity mandates; fund research on pseudonymous accountability mechanisms that preserve both immersion's and inclusion's values.

4) Embed accessibility and inclusion criteria as first-order requirements in EU funding and pre-commercial procurement for immersive services.

1.7.3 Standards Participation and Alignment

5) Establish coordinated European inputs and liaisons across ITU, ISO/IEC, W3C, IETF and 3GPP, linked to a curated standards register hosted (or mirrored) within the OPENVERSE Observatory; target early wins where gaps block deployment (identity portability, usage policies, safety signals) as well as key related EU initiatives such as the E-Wallet.

6) Encourage alignment between open-source communities and formal Standard Development Organizations (SDOs) to accelerate diffusion while promoting sovereignty and preserving EU economic competitiveness.

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1.7.4 Skills, Capability and Evidence

7) Launch a skills and tools initiative for creators and SMEs (authoring pipelines, interoperable assets, community projects, PPPs, UX for accessibility), coupled with an evidence programme tracking outcomes via the Observatory (use cases, KPIs, costs/benefits assessment).

8) Expand ethical-legal guidance and benchmarks (privacy, inclusivity, AI transparency) into sector-specific checklists and EU-wide good practice and exemplary case repositories.

1.7.5 Sustainability and Market Development

9) Incentivise cross-border demonstrators that combine open standards, data-space collaborations, competence exchange and co-creation methods, with pathways to procurement and scale-out, and access roads to innovation-centred financing programmes.

10) Use the Observatory as a one-stop "policy operations" asset—hosting roadmaps, standards' maps, funding windows, and curated showcases—maintained through external contribution workflows beyond project end.

2. BUILDING ON TASK 2.4: THE TECHNOLOGY FORESIGHT EXERCISE

2.1 OVERVIEW AND PURPOSE

This section outlines the outcomes of the OPENVERSE foresight process, the duty of OPENVERSE Task 2.4 (and its corresponding Deliverable 2.3), which was meant to serve as a first strategic step towards an EU policy roadmap for Virtual Worlds and Web 4.0. It is based upon the idea that Europe's success in shaping immersive, intelligent virtual ecosystems will depend on its ability to align industrial, research, with ethical and governance capacities—using targeted policy instruments, institutional mechanisms, and value-based design principles. For that reason, the foresight exercise as well as the produced deliverable emphasise 1) a main time horizon, centred on 2030, 2) a longer-term foresight perspective (2040–2050+), via backcasting considerations, but ensuring that near-term decisions remain coherent with broader societal transitions, resilience goals, and Europe's geopolitical and economic ambitions.

Core Insight: The strategic agency of human, societal and geopolitical factors—not only the technological capability—will determine whether Europe can lead in Virtual Worlds and Web 4.0. This requires constructive governance architectures that are modular, anticipatory, and aligned to human-centred values, but also, coupled with sustained investments in several key innovative initiatives and enabling infrastructures.

2.2 THE OPENVERSE FORESIGHT APPROACH

The foresight exercise was a learning process, encompassing a sequence of four integrated workshops and the supportive participation and contribution of over 40 experts. It can be highlighted as follows:

- Scope and process: The foresight work developed three exploratory scenarios to map the pathways for virtual worlds in Europe. These scenarios helped identify decisive factors and strategic levers.

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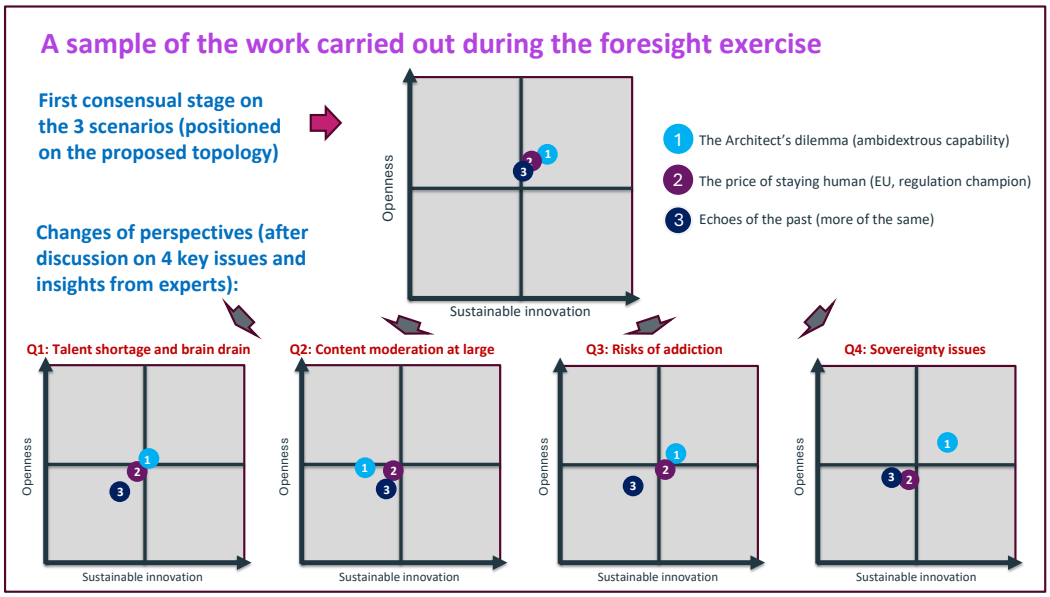
- Time horizons: While 2030 is the operational horizon, the approach also targets longer-term issues. Backcasting from 2040 and 2050 may help inform today's policy design to avoid myopic, merely reactive regulation and integrate in the reflection some still unclear stakes, such as the impact of the environmental load of the digital or the development of brain-machines/brain-computer interfaces (BCI).
- Strategic enablers: The analysis pinpoints AI, extended reality (XR), edge computing, IoT, 5-6 G protocols, semantic technologies and standards, and virtual asset interoperability as key cross-sector enablers. These should support scalable applications across industry and society.

2.3 FORESIGHT AS A CO-CREATION PROCESS

Through the structured and duly exploited involvement of over 40 participants of diverse specialities, the four workshops' sequence led to the design and substantiation of 3 scenarios for 2030, with options for the longer-term. These three scenarios were not proposed as the result of a top-down expression, thereafter merely validated, but on the contrary co-defined within the workshops thanks to a variety of challenges to confront (see below, Figure 2), as the means allowing to fine-tune them.



A sample view of the type of co-creation exercises, showing scenario variability

These three scenarios which the foresight exercise eventually defined and discussed, can be summarised as follows:

Scenario 1: The Architect's Dilemma (developing our ambidexterity)

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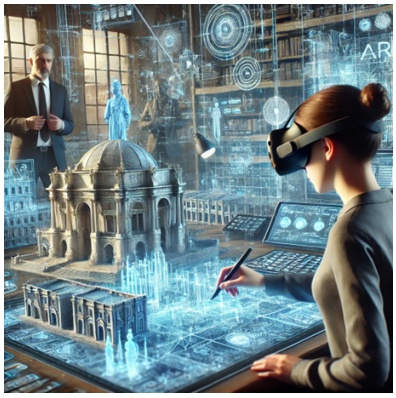		Key characteristics: ▪ **Flexibility vs. predictability:** Adaptive governance must still provide legal certainty and investment security ▪ **Decentralisation vs. accountability:** Dispersed governance risks incoherence without clear coordination structures ▪ **Innovation vs. integrity:** The line between experimentation and exploitation requires constant re-assessment and self-reflexivity

The Architect's Dilemma scenario

Scenario 2: The Price of Staying Human (values will eventually make a difference)

		Key characteristics: ▪ **Ethical coherence vs. operational agility:** High standards can slow down experimentation and market uptake ▪ **Global leadership vs. internal dissatisfaction:** External recognition clashes with domestic frustration over rigidity and complexity ▪ **Oversight without ownership:** Citizens are protected but rarely empowered to directly shape digital governance, too often lagging against less restricted competitors

The Price of Staying Human, scenario # 2

Scenario 3: Echoes of the Past (More of the Same)

		Key characteristics: ▪ **Convenience vs. Autonomy**: Individuals benefit from seamless digital services but surrender agency and data sovereignty. ▪ **Stability vs. Innovation**: Large platforms ensure continuity, but they stifle smaller-scale experimentation and cultural diversity. ▪ **Fragmentation of norms**: Conflicting standards on digital dignity, identity, and posthumous rights emerge across jurisdictions.

Echoes of the Past (scenario # 3)

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What is important for the Roadmap, as it is by nature more focused on the journey towards a goal than on the objective of exploring diverse futures to better get prepared for them, is the necessity we had, to fully connect Task 2.4 and Task 2.5 (the one which has led to this deliverable), to punctuate this exploratory work with a preferential track or ideal scenario proposal, which goes as follows:

- Regarding regulation and innovation, **emphasising an ambidexterity requirement[27], with a governance grammar that is plural and evolving**, based upon flexible narrative tools to mediate between complexity and choices.
- **Targeting both human-centric and market-oriented expectations**, as well as supporting **SMEs but collaborating with emerging champions**, to keep learning the rules of the entertainment strand, but **developing more professional XR/VW applications**, and being always agile and future-sensitive, rather than fixed and constantly risking obsolescence or external dominating influences (e.g. interoperability as a learning industrial leveraging process).
- **Building on European strengths, not only the Single Digital Market, but also the most competitive sectors and value chains, science-industry collaborations, PPPs, dynamic communities of practice, pioneering regions and cities, as well as the diversity of social and cultural life,** meaning that education, in the sense of training, and creativity, should unfold with equal legitimacy, and that industrial strengthening in these diverse virtual and XR-augmented places, in policy terms, **should lead to incentivised co-Innovation ecosystems.**
- **New financing means should come to strengthen the existing instruments and open innovation schemes to complement strict IPR objectives**, to boost the effects of the above-mentioned EU strengths, **involving a diversity of XR and VW designers and makers,** either as entrepreneurs or as communities.

2.4 KEY TOPICS AND FINDINGS TO BE CONSIDERED

2.4.1 Europe's Position in the Global Context

The EU efforts to strive and maintain a strong position in a highly competitive and uncertain context implies at least the following mindset characteristics:

- Comparative advantage: Despite strong momentum in the U.S., China, South Korea, Japan, Australia, and parts of the Middle East, Europe's edge lies in integrating innovation with normative clarity, participatory governance, and user rights protection, without sacrificing its science-industry innovative strength. This translates into trust, legitimacy, sustainable uptakes, and economic development aspirations.
- Strategic posture: The foresight process recommends replacing strategic uncertainty with "structured experimentations," skills development, and focused investments in areas of EU excellence. Rather than betting on a single future that would be better than competing scenarios, Europe should recombine scenario elements into a coherent, EU-relevant "preferential track."

[27] In this particular case, we can define ambidexterity as the capability for Europe to adopt a dual approach regarding its strategic objectives —supporting modular governance experiments and economic innovation while ensuring alignment with EU-level principles (human-centred design, ethics, digital sovereignty).

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2.4.2 Territorial Synergies and Inclusive Innovation

There is a need to build on strengths, among which we can find in prominent places 1) the European cultural and specialisation diversity as well as 2) the capacity to build effective innovative value chains, two essential capacities which suggest action-led initiatives:

- Regional leadership: Dynamic regions such as Bavaria, Catalonia, North Rhine-Westphalia and the Paris area are emerging as hubs for immersive technologies. Harnessing interregional leadership and cross-border synergies will be essential for scaling re-industrialisation.
- SMEs and decentralisation: Echoing Enrico Letta's "Much More Than a Market" report, the document stresses empowering SMEs and decentralised innovation. Embedding smaller actors and local ecosystems into a scalable model strengthens technological sovereignty and resilience.
- Community-driven collaboration: Beyond formal PPPs, the text advocates for community-based interregional collaborations, regional innovation hubs, and civic technology-supported initiatives. These mechanisms ground virtual ecosystem development in pluralism and territorial inclusivity.
- Role of cities: Cities and city networks should serve as testbeds for participatory governance and immersive public services. Their proximity to users and contextual understanding make them ideal sites for prototyping inclusive Virtual Worlds addressing local economic and societal needs.

2.4.3 Experimental Governance and Sandboxes

The Policy Briefs, as section 2.3 will show, is also involved in the making of an EU strength dedicated to virtual worlds' development. As the task is still in progress, at this stage, we will emphasise the two following objectives:

- From static rules to iterative learning: The document calls for regulatory evolution from static frameworks to iterative, sandboxed environments that support IPR-aware and open innovation models alike.
- Policy-in-the-loop: Foresight and co-creation should be embedded directly into regulatory cycles. Sandboxes allow real-world testing of immersive applications under controlled conditions, enabling governance to evolve alongside technology rather than lag behind it.

2.4.4 Co-Creation and Multi-Generational Design

Several tasks of the OPENVERSE project address this co-creation objective and what is the current state of the OPENVERSE members' reflection can be, at the moment (some of the tasks are still ongoing), summarised as follows:

- Design agency: Regulatory sophistication must be matched by investment in enabling infrastructure and value-centred applications across industry and services. Co-creation should be elevated as a foundational design practice across sectors—industry, services, entertainment, education, and socialisation.

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- Human-centred compass: Echoing UNESCO's approach, the text frames users not merely as consumers but as cultural agents, helping shape plural and inclusive digital futures. Co-creation expands legitimacy, improves design fidelity, and enhances adoption.
- Multi-generational inclusion: Virtual Worlds should be designed for digital natives and ageing populations alike. Applications in health, professional upskilling, social connection, and lifelong learning can improve wellbeing and social cohesion.

2.4.5 Priority Investment Areas to Translate Values into Capability, the Roadmap Should Prioritise

Technologically speaking, the landscape is quite large, as some WP5 and WP6 tasks have shown it, but decisive investments may be wisely focused on the following challenges:

1. AI for emotional intelligence and content creation/curation: Tools that recognise affects, enhance content quality and relevance, and support safer, more empathetic interactions.
2. Decentralized and open-minded architectures compatible with emerging EU instruments for identity and data sovereignty: User-controlled identities, "consentable" data flows, and interoperable credentials to operationalise digital sovereignty.
3. Immersive XR for public services: Applications that improve state agility and service delivery in education, healthcare, environmental management, and industrial support—especially for workforce development and crisis response.

2.4.6 Cultural, Symbolic, and Cognitive Dimensions

This broad topic is still the subject of a lot of research and debates, we can propose it as a component of the roadmapping duty in the following summary:

- From transactions to meaning: The scenarios show that memory systems, synthetic environments, and AI-mediated identities are becoming core to digital life, particularly for younger generations. Policies must therefore extend beyond informational and transactional safeguards to include epistemic and affective integrity.
- Memory and identity: Institutional capacity is needed to manage synthetic content, memory rights, and digital heritage with transparency, pluralism, and emotional awareness. This includes stewardship of digital artifacts, provenance, and long-term accessibility.
- Psychological effects and digital wellbeing: The roadmap should proactively address risks from extended immersion and screen time—virtual dependence, emotional overload, and mental health impacts—especially among younger users. This requires responsible design defaults, wellbeing standards, and alignment with public health strategies.

2.4.7 Safety, Ethics, and Enforcement

Safety, consumers' protection, ethical stakes and human rights concerns in the digital realm are numerous, but the OPENVERSE project focused on those mainly linked to the development of virtual worlds and the Web4.0:

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- Beyond GDPR: While data protection remains foundational, immersive contexts demand expanded protections, including safeguards against cyberbullying, identity theft, harassment, deliberate misinforming communication and other illicit behaviours that manifest differently in 3D and embodied environments.
- Coordinated enforcement: Effective governance will require coordination with EUROPOL, data protection authorities, and cross-border enforcement mechanisms. Preventive tools, transparent recourse, and clear liability frameworks should be integrated into platform design and public policy.
- Trust architectures: To maintain user safety and confidence, the roadmap should back value-led governance with robust technical capacity—verifiable identities and credentials, content provenance (e.g. watermarking and authenticity signals), risk monitoring, and transparent moderation systems.

2.5 Strategic Implications and Recommended Actions

Upon the findings of the foresight exercise, the following can be recommended:

- To build a coherent governance-innovation stack: Combine modular, sandboxed regulatory frameworks with interoperable technical standards and trust architectures. This reduces fragmentation, accelerates learning, and aligns innovation with EU principles.
- To invest in cross-sector enablers and interoperability: Prioritise AI, XR, edge, semantic standards, and virtual asset interoperability to unlock scalable use cases across manufacturing, health, public services, culture, and education.
- To leverage Europe's normative advantage: Embed human-centred design, rights-based data governance, and participatory mechanisms into the fabric of Virtual Worlds. Make these features a competitive differentiator in global markets.
- To cultivate territorial diversity as a strength: Use interregional networks, city-level pilots, and SME-focused programs to scale innovation through the Single Market. Support mechanisms that help small actors plug into larger value chains and standards' bodies.
- To embed foresight into regulatory cycles: Institutionalise co-creation, scenario testing, and impact assessment within EU and Member State regulatory processes. Adjust rules iteratively based on evidence from sandboxes and pilots.
- To address cultural and psychological dimensions: Develop standards and tools for moderated data stewardship, synthetic content management, and affective integrity. Coordinate with health authorities on digital wellbeing and mental health protections for immersive environments.
- Strengthen law enforcement and cross-border cooperation: Equip authorities and platforms with harmonised protocols for reporting, evidence handling, and cross-jurisdictional action on immersive-specific harms.
- Foster skills and multi-generational inclusion: Support workforce upskilling for immersive tech, design literacy for co-creation, and accessibility by design to ensure older adults and diverse communities can benefit equally.

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The OPENVERSE foresight exercise provided a strategic compass for Europe's approach to Virtual Worlds and Web 4.0. Its central message is that Europe can lead by combining technological ambition with normative coherence, participatory governance, and territorial inclusivity. Achieving this requires governance ambidexterity, structured experimentation, and sustained investment in the enabling stack—AI, XR, edge, semantic standards, and interoperability. It also requires recognising and addressing the cultural and psychological dimensions of immersion, ensuring that safety, meaning, and wellbeing are integrated from the outset.

By coordinating industrial policy with modular governance, empowering regions and SMEs, embedding foresight into regulation, and prioritising user rights and co-creation, the EU can operationalise a value-based leadership model. This model does not merely keep pace with global competitors; it charts a distinctive, human-centred path for the future of immersive technologies and digital society.

3. THE POLICY DIALOGUE ACTIVITY AND THE POLICY BRIEFS

3.1 OBJECTIVE AND ALIGNMENT

OPENVERSE aims to contribute to the 2030 Policy Programme: Path to the Digital Decade, via open and co-created virtual worlds. From this perspective, core deliverables include: 1) three policy briefs (WP7), 2) a co-created roadmap-related output with policy-makers and stakeholders (informed by tasks on ethics, IPR, governance), and 3) a policy dialogue program linked to workshops and OPENVERSE dialogues.

The Dialogue events are designed to gather a broad set of stakeholders and feed insights into the Policy Briefs and the roadmapping process. An early example: a Dialogue session on January 9, 2025, explored unlocking investments and cross-border hiring.

The scope and the stakeholders of this activity is straightforward: producing a stimulating reflection, with a focus on Europe-wide implications for SMEs and startups in immersive tech and virtual worlds (VW), within the Digital Single Market. This means in particular an emphasis on cross-border collaborations, market integration, regulatory clarity, and alignment with European values (openness, inclusivity, ethics, environmental sustainability).

The dialogue program is intended to complement the briefs by engaging a wide range of stakeholders (policy-makers, industry, regulators, researchers, SMEs) through co-creation workshops and e-workshops and suggesting/validating effective policy concepts, metrics, and implementation pathways, in other words feeding the roadmapping process and the development of concrete policy recommendations and implementation timelines.

While the Policy Dialogue component is essential to ensure inclusiveness and legitimacy of policy measures, with a continual stakeholder engagement objective of refining actions, measuring impact, and adjusting implementation, this activity is also complemented and concretely conveyed by three Policy Briefs. So far (as of Sept. 30, 2025), one full Brief has already been delivered, one has been drafted and will be delivered with the same deadline as this Deliverable, while the last one will be generated in 2026.

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3.2 THE FIRST POLICY BRIEF

Title*: Immersive Tech and Virtual Worlds: Empowering European SMEs and Startups to overcome challenges in doing cross-border business in the Digital Single Market*

3.2.1 Core Issue of This First Brief

The first Brief examines the hurdles that have to be identified and overcome for EU SMEs involved in immersive technologies and virtual worlds, in particular the barriers that impede cross-border activity, limiting competitiveness and European leadership towards open, ethical, and environmentally responsible virtual worlds.

The goal is, indeed, to strengthen European competitiveness by enabling market growth, cross-border collaboration, talent retention, and reducing brain drain.

The context and scope of this objective are defined, in our specific case, by the immersive technologies that are AR, VR, MR, altogether making the XR cluster and virtual worlds, which are characterised as persistent, real-time 3D environments with avatars. This technological focus is developing an important potential across different sectors of activity, such as healthcare, education, manufacturing, retail and entertainment, the stake being to keep being aligned with European values despite harsh international competitiveness.

The focus on SMEs and startups operating in the EU and addressing cross-border business within the Digital Single Market is a methodological pathway[28] to stimulate makers and designers of all kinds to help businesswise these entrepreneurs to match policy efforts to positively confront different existing gaps.

3.2.2. Case-Based Insights from Two Concrete Illustrative SMEs

The Brief has examined two stimulating cases, OneBonsai (OneBonsai - Deep Tech, Real Impact) and Ready Player Me (Integrate an avatar creator into your game in days - Ready Player Me), which convey the following characteristics:

- OneBonsai
    - Funding: fragmented landscape; difficulty advancing beyond seed rounds and scaling.
    - Regulatory environment: complex, multi-jurisdiction compliance is costly/time-consuming.
    - Market access: cross-border growth hampered by fragmentation.
    - Hiring: legal/administrative burdens in cross-border recruitment.
- Ready Player Me
    - Funding: similar constraints; need for near-term capital to scale.

[28] Based upon desk research (e.g. 2024 Single Market/Letta reports) and ethnographic insights, with inputs from the Informal policy dialogue conducted on 9 January 2025.

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- Talent: competition for specialised talent; cross-border recruitment complexities.
- Regulation: GDPR and evolving domains affect operations.
- Scaling: operational and regulatory hurdles as EU markets expand.

Key lessons from the analysis of these two cases:

- Fragmentation and regulatory complexity are the principal barriers; funding and talent constraints magnify cross-border growth challenges.
- Compliance costs and cross-border HR requirements increase cost and risk, potentially slowing European leadership in virtual worlds.

3.2.3 Conclusions and Strategic Policy Recommendations

Policy recommendation needs

Upon the work carried out for this first Brief, policy recommendations suggest a need for:

- Regulatory harmonisation across member states.
- Targeted SME support (financing, access to markets).
- Increased interoperability and digital connectivity.
- Incentives on workforce mobility and skills development.
- Strenghtening digitised administrative processes and digital literacy in the administration to reduce bureaucracy.

The Overarching message to be more specific to the Virtual worlds:

A truly European VW ecosystem requires cross-border digital/regulatory alignment, reduced bureaucratic burdens, and targeted SME support to unlock investment, scale, and talent mobility.

Four thematic policy zones with concrete actions

1. "Show me the incentive", with the following actions:

   Create or expand funding channels for scale-ups; streamline grant-to-seed-to-scale transitions; offer tax incentives or matched funding for cross-border projects.

2. "Mind the gap", with the following actions:

   EU-wide funding instruments with harmonised criteria; co-investment schemes; reduce due diligence with standardised impact metrics and templates.

3. "Lead by example", with the following actions:

   Accelerate SME-friendly regulatory harmonisation for digital markets, data protection, and cross-border employment; propose a “28th regime” for SMEs; promote a One-Stop Shop (MOSS-like) for immersive tech compliance.

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4. "Put your money where your mouth is", with the following actions:

   Invest in interoperable digital infrastructure and real-time data ecosystems; support cross-border regulatory compliance, market analytics, and talent mobility; establish shared sustainability and ethics standards.

Cross-cutting enablers

For these objectives, it is necessary to mobilise cross-cutting enablers:

- Interoperability and common standards accelerate cross-platform data/identity standards to ease cross-border collaboration.
- Digital connectivity increases with robust broadband/5G and cloud infrastructure that can support real-time immersive experiences and cross-border operations.
- Workforce mobility and skills need to be supported with reskilling/upskilling, mobility programs, open to the recognition of qualifications.
- Data governance and ethics have to be aligned with GDPR and emerging EU rules, but also to provide SMEs with practical guidance and tooling.
- Key implementation considerations include: the prioritisation of regulatory harmonisation and the deployment of SME-friendly processes to unlock investment, with due monitoring and evaluation, meaning effective metrics on cross-border activity, investment, employment, skills development, time-to-market reductions, and stakeholder engagement.

3.3 THE SECOND POLICY BRIEF

(status: draft /final version due by the end of October 2025)

Title*: Regulatory Sandboxes for Virtual Worlds Innovation: A Framework for EU Leadership*

3.3.1 The Core Idea

The Second Brief proposes a reflection leading to a regulatory sandbox regime tailored to European startups/micro-enterprises in the MV/VW space.

- Anchored in the “28th Regime” concept, i.e. a voluntary, harmonised, pan-EU framework that sits alongside Member State laws.
- With a middle path between ex ante regulation and laissez-faire, enabling real-world testing with safeguards, iterative regulatory learning, and evidence-based rulemaking.
- With case studies from Europe and abroad to show momentum in fintech/sandboxes, a context in which AR/VR, digital twins and virtual worlds represent an important stake, often requiring multi-country coordination.

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3.3.2 Roadmap and Structure

The Brief outlines a framework for sandboxes versus other non-regulatory approaches (safe harbours, technology-free zones, etc.), identifying four VW-specific areas of concern such as data governance, interoperability, cybersecurity, and GDPR compliance. The implications for policy are significant, in particular:

- A harmonised sandbox regime could reduce cross-border regulatory uncertainty and accelerate innovation in MV/VW.
- It would provide a controlled environment to test governance, data handling, safety, and cross-border operations before broad deployment.
- The approach supports evidence-based policy-making and as such, can feed this Deliverable 2.4/1 (M24) and the two Task 2.5 workshops.

3.3.3 Synthesis and Practical Implications

From the conjunct findings and proposals of this Brief, the following can be recommended:

1) For governance and policy-makers
    - Advance regulatory harmonisation initiatives early (e.g. cross-border employment, GDPR alignment, and data governance standards).
    - Develop a One-Stop Shop concept for immersive tech compliance and a streamlined “SME-friendly” regulatory framework (the proposed 28th regime).
2) For funding and market access
    - Pilot EU-wide co-investment schemes with standardised due diligence processes and impact metrics.
    - Create cross-border grant-to-scale pathways with clear milestones and accessible funding for scale-ups.
3) For the sandbox framework
    a. Define the scope, governance, and safeguards of the "28th Regime".
    b. Establish cross-border sandbox governance bodies and a coordinated oversight mechanism.
    c. Develop case-study criteria to evaluate sandbox outcomes and feed into rulemaking.

3.4 THE THIRD POLICY BRIEF

The third Policy Brief will be delivered in M36 of the OPENVERSE project, namely at the end of it, but, of course, there will be earlier drafts to be discussed on this highly important matter. Its title: Trust Tools for Virtual Worlds.

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The blueprint of this incoming Brief is:

- To **Diagnose trust gaps in virtual worlds**: the deliverable aims to critically assess the shortcomings of current digital infrastructure, particularly how the absence of embedded trust mechanisms (e.g. identity and payment layers) undermines user confidence in immersive environments.
- To **Introduce "technological trust" solutions**: it presents decentralised technologies—blockchain, decentralised identities, privacy-enhancing technologies (PETs)—as viable tools to build trust “by design” in virtual worlds without relying solely on central authorities.
- To **Guide EU policy-makers and stakeholders**: it provides actionable policy guidance for European institutions to strategically lead in shaping a trustworthy, open, and sovereign digital infrastructure aligned with EU values.

The methodology that will be used for the design and achievement of that third Policy Brief includes:

- **A contextual and historical analysis**: traces the evolution of the internet to identify foundational gaps in trust infrastructure (e.g. identity and payments) and their consequences on today’s digital society.
- **A technological landscape mapping**: maps of existing and emerging technologies (e.g. blockchain, zero-knowledge proofs, verifiable credentials) capable of addressing identity, governance, and interoperability issues in immersive environments.
- **A use case and risk-based evaluation**: evaluates real-world and potential applications of decentralised technologies in virtual worlds while analysing key challenges related to data governance, identity, safety, and centralisation.

The final workshop dedicated to roadmapping and policy recommendations, to be held in the last part of the project duration, namely at the end of summer 2026, will include all the insights from this last Policy Brief activity, thanks to the collaboration that has been established between LC and IF, but also with other Consortium members involved in related tasks (ethics and governance, digital asset monetisation, security issues, etc.).

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ANNEX II: EU INSTRUMENTS USED FOR EXERCISE #2

Instruments	Brief explanation
Digital Markets Act (DMA)	The Digital Markets Act has been enacted to ensure fair, contestable digital markets by regulating large "gatekeeper" platforms (e.g. app stores, search, social, OS, online ads, browsers, messaging). This is meant to allow business users fair access and data portability; ban self-preferencing; enable interoperability (notably for messaging); restrict combining personal data across services without consent; allow alternative app stores/payment systems in some cases.
Digital Services Act (DAS)	The Digital Service Act is meant to create a safer, more transparent online environment governing how platforms handle illegal content, systemic risks, and user rights. For all intermediary services in the EU (hosting, platforms, marketplaces, social media); and extra duties for Very Large Online Platforms/Search Engines (VLOPs/VLOSEs) This means some key obligations: Notice-and-action for illegal content; transparency on algorithms/ads; limits on targeted ads (no targeting minors or using sensitive data); traceability of traders on marketplaces; risk assessments and mitigation for VLOPs/VLOSEs; Let's also specify that the DMA focuses on market power and competition of dominant platforms; while the DSA focuses on content, safety, transparency, and user rights across online intermediaries.
Cyber Resilience Act (CRA)	A EU regulation setting baseline cybersecurity requirements for "products with digital elements" (hardware and software) placed on the EU market. Think secure-by design/default, vulnerability handling, security updates, transparency, and CE marking. The CRA applies to : • Manufacturers, importers, and distributors of connected hardware and software sold in the EU. • "Critical" products (e.g. operating systems, identity/access management, industrial control components, password managers, certain network/security products) face stricter conformity assessment. • Notably out of scope or handled elsewhere: sector-regulated products (e.g. medical, aviation, automotive), and non-commercial open-source developers (open-source used commercially can still bring obligations for the commercial placer-on-the-market).
AI Act	The EU's horizontal law for AI. It sets harmonised rules based on risk, applies extraterritorially (if AI is placed on the EU market or its output is used in the EU), and complements GDPR, product-safety law, and NIS2. It applies to providers (developers placing AI on the market), deployers (users), importers, distributors, and product manufacturers integrating AI. It also covers general-purpose AI (GPAI)/foundation models, with extra rules for "systemic-risk" GPAI. It is a risk-based framework, based on four levels: • Prohibited AI (ban): e.g. unacceptable risks like certain types of social scoring, untargeted facial scraping, some emotion recognition in the workplace/education, manipulative or exploitative techniques, and real-time remote biometric ID in public spaces (with narrow law-enforcement exceptions). • High-risk AI: AI used in safety components or sensitive areas (e.g., critical infrastructure, medical devices, employment/HR, education, essential services, law enforcement, migration, justice). Requires CE marking after conformity assessment and lifecycle controls. • Limited-risk: Transparency duties (e.g. disclose AI interaction, label deepfakes/synthetic content, inform when using emotion recognition or biometric categorisation). • Minimal-risk: Most AI (e.g. spam filters, games) — no new obligations, but encouraged to follow voluntary codes/standards.

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Data Act	Horizontal law on access to and use of data from connected products and related services (especially IoT), plus rules for fair B2B/B2G sharing and cloud/service switching. It complements—not replaces—GDPR. In force since January 2024, it applies to manufacturers of connected products, providers of related services, holders/users of industrial/IoT data, cloud and other data processing service providers, and public bodies invoking B2G access. Its provisions are as follows: User access to product/service data: Users of connected devices must be able to access data they generate (including telemetry) and have it shared with third parties they choose, on fair, reasonable, nondiscriminatory terms; safeguards for trade secrets apply. • Fair B2B terms: Protects SMEs from unfair data-sharing contract terms; encourages FRAND conditions and model clauses. • B2G "exceptional need": Public bodies can request data from companies in defined emergencies or other narrowly specified situations, with compensation and safeguards. • Cloud/data processing switching: Providers must enable switching between cloud/data processing services (portability, interoperability) and phase out egress fees/technical lock-in. • Interoperability and smart contracts: Interoperability requirements for data spaces and basic requirements for smart contracts used in data-sharing (e.g. access controls, safe termination). • International access safeguards: Limits unlawful foreign access to non-personal data, mirroring GDPR-style protections.
Data Governance Act	An EU framework to boost trustworthy data sharing. It does not force sharing; it creates mechanisms and trust rules so more public- and private-sector data can be reused. Pit applies to public bodies holding protected data; data intermediaries/platforms; organisations running data-altruism schemes; users/re-users of such data. In force and applicable since September 2023, it is based on the following pillars: • Re-use of protected public-sector data: Allows re-use of public data that's commercially confidential, personal, or IP-protected under strict safeguards (secure processing, anonymisation, no re-identification, transfer restrictions). • Data intermediation services: "Neutral" data-sharing brokers (for B2B, B2C, or industrial data spaces) must notify authorities and comply with neutrality, transparency, and security rules. • Data altruism: Lets organisations register as "data altruism" entities to collect voluntary data donations for the public good. • Governance: Sets up the European Data Innovation Board and rules for international data access/transfer safeguards.
General Data Protection Regulation (GDPR)	Entered into force in 2018, the GDPR is a comprehensive data protection law in the European Union and European Economic Area that regulates how personal data is collected, stored, processed, and shared.It applies to all organisations (in the EU/EEA or outside) that process personal data of individuals in the EU/EEA. It covers any processing activity, including collection, storage, use, disclosure, and retention. Its key principles are lawfulness, fairness, transparency, purpose limitation, data minimisation, accuracy, storage limitation, integrity and confidentiality (security), and accountability. And 8 individual rights. Should be added: the DPIA level: DPIAs and governance: • Data Protection Impact Assessments (DPIAs) for high-risk processing. • Maintain records of processing activities. • Design by default and data protection by design.
EU ID	EU ID (European Digital Identity) is a concept and a framework to give EU residents a standardised, interoperable set of digital identity attributes and authentication across member states. Relevant instruments and developments: • eIDAS Regulation (Regulation (EU) No 910/2014) provides the legal basis for cross-border electronic identification, authentication, and trust services. It enables member states to recognise electronic IDs and signatures issued in other member states when using interoperable, trusted components. • EU-wide proposals and legislative work to create a common European digital identity framework, including rules for issuing national eIDs, interoperable digital wallets, and mutual recognition of

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	certificates (often discussed under the umbrella of "EU digital identity" or "European Digital Identity framework"). • Relationship to eIDAS: relies on the eIDAS trust framework, qualified trust service providers, and digital certificates. The wallet itself would be a consumer-facing interface to present verifiable credentials securely.
«eWallet»	In fact, we are talking about the EU digital identity wallet, which is a user-controlled, interoperable digital wallet designed to hold and present verifiable credentials and identity attributes issued by trusted authorities. It enables individuals and, in some cases, organisations to prove who they are and certain attributes (e.g. age, nationality, professional qualifications) across EU member states in a privacy-preserving way. It aims to achieve: • Cross-border identity verification: A single, recognised way to prove identity when using services in different EU countries. • Privacy-by design: Minimise data sharing by supporting selective disclosure (only reveal the necessary attributes). • Portability and user control: The user manages credentials in a secure wallet, rather than repeatedly re-uploading documents. • Interoperability: Standards-based (e.g. W3C Verifiable Credentials, Decentralised Identifiers) to enable credentials issued by trusted authorities (governmental or other trusted entities) to be accepted across services and borders. Work in progress.
Blckchain related regulations	Beside all the data-related protective measures, either general or dedicated to specific sectors (e.g. finance), as well as the Anti-Money Laundering Directive (Extends AML obligations to crypto-asset service providers (CASPs) like exchanges and wallet providers, including customer due diligence (CDD), record-keeping, and reporting) or specific IPR regulations, the main instrument to regulate blockchain-related applications in the EU is MICA , the Markets in Crypto-Assets Regulation proposal, which aims to create a comprehensive regulatory framework for crypto-assets not covered by existing financial rules, concerning issuance of crypto-assets, trading platforms, wallets, custodian services, stablecoins, and certain service providers, on such issues as authorisation requirements, capital and consumer protection, investor disclosure, prudential safeguards, and market integrity.
The Digital Single Market (DSM)	A strategic EU initiative aimed at removing digital barriers across member states to create a unified, cross-border digital market for goods, services, data, and people. It aims to boost competition, innovation, and consumer choice by making it easier to buy and sell online, access digital services, and move data across borders within the EU. It score pillars are : • Digital infrastructure and connectivity: high-speed networks, 5G rollout, and nationwide broadband to support online services and digital business. • e-Commerce and cross-border trade: harmonised rules to reduce fragmentation, improve online consumer protection, and enable smoother cross-border shopping and service delivery. • Digital services and online platforms: clearer rules for platforms, online advertising, and consumer rights in the online environment. • Data economy: free flow of data within the EU, data governance, and support for data-driven innovation while protecting privacy and security. • Digital skills and inclusion: programs to improve digital literacy and ensure everyone can participate in the digital economy. • Next-generation technologies: support for AI, cloud, cyber security, and emerging tech while aligning with EU rules and ethics. • Public sector and e-government: easier cross-border public services, digital identification, and interoperable digital public services. Its key mechanisms • Legislation and policies: targeted regulations and directives to harmonise rules (e.g. consumer protection, e-commerce, telecoms, data protection).

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	• Cross-border digital identity and trust: initiatives like the EU digital identity framework to enable secure cross-border online authentication. • Standards and interoperability: shared technical standards to ensure services work seamlessly across borders. • Enforcement and governance: EU bodies coordinating enforcement, consumer protection, and competition in the digital space.
The 28th Regime	The 28th regime is proposing a legal framework of European Union rules which do not replace member states' own national rules but are an optional alternative to them. The number 28 in the name comes from 27 member states in the EU and their national legal systems, which are extended by a new EU-wide alternative. The concept of a 28th regime, a recurring European topic, has resurfaced in very recent European news, particularly with the release of Mario Draghi's report on European competitiveness and the start of the new mandate of the European Commission, on 1st of December. The concept of an optional legal framework to harmonise contract law within the European Union has been raised repeatedly, for example in the 2011 opinion of the European Economic and Social Committee. This opinion highlighted the potential benefits of such a regime, a relevant tool for reducing disparities among national legal systems and facilitating cross-border transactions. Despite proposals that have gained traction in certain areas (such as the European unitary patent), the concrete implementation of a 28th regime remains untapped and constitutes a major challenge for the European Union.
Digital Innovation Hubs	The EU's European Digital Innovation Hubs (EDIHs) are a network of regional "onestop shops" that help SMEs and public sector bodies adopt advanced digital technologies. They are funded mainly under the Digital Europe Programme, cofunded by Member States/regions. They promote the following: • Test before invest: access to testbeds, labs, and expertise in AI, data, cybersecurity, HPC, cloud/edge, robotics, etc. • Skills and training: short courses, mentoring, and hands-on upskilling Business and finance support: advice on investment, IP, standards, and accessing EU/national funding.
Horizon Europe (HE)	Horizon Europe is the EU's 2021–2027 framework programme for research and innovation, with a budget of about €95.5 billion. It funds projects to strengthen scientific excellence, boost competitiveness, and tackle global challenges like climate, health, and the digital transition. Within Horizon Europe, let's mention the EIC Accelerator, a funding instrument under the European Innovation Council (EIC) in Horizon Europe (Pillar III: Innovative Europe). It succeeded the SME Instrument from Horizon 2020.
Digital Europe Programme (DIGITAL/DEP)	The Digital Europe Programme (DEP) is the EU's 2021–2027 programme focused on deploying and scaling key digital capacities—not research, but employment and uptake (using existing or near-market tech at scale). Budget: about €7.5 billion.
European Structural and Investment Funds (ESIF)	European Structural and Investment Funds (ESIF), is the EU's main place-based funding for reducing regional disparities (largely grants, with some financial instruments). In 2014–2020, ESIF covered five funds: ERDF, ESF, Cohesion Fund, EAFRD (rural development), and EMFF (fisheries). In 2021–2027, the successor setup is often called Cohesion Policy/Shared-Management Funds: • ERDF, ESF+ and the Cohesion Fund (core cohesion funds), plus the Just Transition Fund (JTF). EMFAF (maritime/fisheries), while EAFRD continue but are managed under their sectoral policies.
InvestEU	It is the EU's flagship investment programme for 2021–2027 (successor to the Juncker Plan/EFSI). It uses an EU budget guarantee to de-risk projects and crowds in private/public capital. Core pillars:

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	• InvestEU Fund: An EU guarantee (about €26 billion) provided to "implementing partners" (mainly the EIB Group and national promotional banks), aiming to mobilise roughly €370+ billion in investment. Instruments include loans, guarantees, equity/venture capital, and risk-sharing. • InvestEU Advisory Hub: Free/low-cost advisory, feasibility support, and capacity building to make projects bankable. • InvestEU Portal: An online pipeline where project promoters can showcase projects to investors.
European Institute of Innovation and Technology (EIT)	The European Institute of Innovation and Technology (EIT and EIT Digital) is a EU body that fosters innovation through Knowledge and Innovation Communities (KICs). EIT Digital focuses on digital innovation and entrepreneurship: • Provides support for business creation, acceleration, and scaling through the EIT Community ecosystem (accelerators, venture investments, and education). • Provides mentorship, access to investors, pilots with corporates, and possibly seed funding.
EU Angels Fund (EAF)	The EAF is a co-investment program managed by the European Investment Fund (EIF). It provides a dedicated, long-term allocation to qualified business angels and family offices and then matches their investments in innovative startups/SMEs on a pari passu basis (typically deal-by-deal, often around 1:1–1:2). It's designed to scale the firepower of experienced angels, not to invest directly. The EIF does diligence on the angel, then co-invests alongside them across multiple deals within agreed parameters. EAF operates via country "compartments" with local public partners. It has been active in multiple EU countries (e.g. Germany, Spain, Austria, Ireland, Italy, the Netherlands, Denmark, Finland, Portugal, and some Baltics), with availability and terms varying by country and funding cycles. Let's also mention that there are other similar programmes, such as, for instance: • EBAN (European Business Angels Network): Europe's umbrella association of angel networks and early-stage investors; good for cross-border syndication and events. • Business Angels Europe (BAE): Federation of national business angel associations across Europe. As well as cross-boarder groups: • Rising Tide Europe: Pan-European women-led angel program/syndicate investing across Europe. • GoBeyond/GoBeyond Investing: Cross-border angel investing community and syndication platform. And strong national programmes, e.g.: • France Angels (FR), BAND/Business Angels Netzwerk Deutschland (DE), AEBAN (ES), IBAN (IT), FiBAN (FI), EstBAN (EE), HBAN (IE), BV Angel Network (NL), BAE/BeAngels (BE), BAN Nederland, etc.
European Savings and Investments Union (ESIU)	"A European Savings and Investments Union to create new savings and investment products, provide incentives for risk capital, and ensure investments flow seamlessly across the EU" / "a refocused EU budget will streamline access to EU funds in line with EU priorities" (Excerpts from the Digital Compass, EU commission, 2025.

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ANNEX III: ETHICS ADVISOR ASSESSMENT REPORT

Project: OPENVERSE (Grant Agreement No. 101135701)
Deliverable: D1.1 – Handbook of Co-Creation Methodologies (V1)
Evaluator: Ethics Advisor (Independent)

1. Overview

This report presents the ethics advisor's assessment of Deliverable D1.1 in relation to the Horizon Europe Ethics Guidelines and the OPENVERSE Ethics Framework. The evaluation focuses on participant inclusion, informed consent, data protection, equality, accessibility, intellectual property, and adherence to the EU Charter of Fundamental Rights.

2. Summary of Ethical Compliance

D1.1 demonstrates strong adherence to EU ethical principles, particularly openness, inclusivity, and human-centric innovation. The deliverable operationalises ethics-by-design through its focus on participatory co-creation in Virtual Worlds and integration of transparent, inclusive engagement practices.

Ethical Area	Assessment	Evidence / Comments
Data Protection (GDPR)	Compliant	No personal data processed beyond aggregate workshop figures; anonymised engagement data only.
Informed Consent	Compliant	All participants voluntarily recruited via open calls and consented under GDPR-compliant procedures.
Equality & Inclusion	Strong	Balanced gender participation; future accessibility inclusion foreseen for D1.2.
Transparency & Open Science	High	Open-source framework and toolkit designed for replication via OPENVERSE Observatory (D6.3).
Intellectual Property	Moderate	Open-source orientation noted; explicit Creative Commons licence to be added in D1.2.

3. Sensitive Points and Mitigation Measures

Area of Sensitivity	Ethical Concern	Observation in D1.1	Mitigation / Recommendation
Recruitment transparency	Indirect online outreach could include users without institutional consent screening	Public calls used in open adult communities	Add confirmation that all participants were 18+ and signed consent forms (GDPR templates, D7.3).
Data minimisation	Community engagement data may reveal moderators or users	Only aggregate data reported	Add sentence confirming no personal or moderator data stored.
Accessibility and inclusion	Limited participation of disabled or under-represented groups	Diversity noted but limited intersectionality	Include accessibility testing and inclusion strategy in D1.2 (per D7.7).
Intellectual property	Potential ambiguity in tool ownership	Co-creation outputs shared openly	Add Creative Commons (CC-BY or CC-BY-SA) licence to Handbook and Toolkit.

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Immersive participation	Possible cognitive or physical discomfort	Short, supervised sessions	Cross-reference D7.7 mitigation on XR psychological safety.

4. Consistency with the Ethics Guide for Advisors

Ethical Principle	Compliance	Comment
Advisory culture and independent oversight	Compliant	D1.1 follows OPENVERSE-wide ethics oversight under WP7.
Principles of respect, beneficence, justice, and integrity	Compliant	Voluntary participation, equality, and informed consent respected.
Consistency with EU and project-level policy	Compliant	Aligned with EC Web 4.0 Strategy, OPENVERSE D7.3/D7.7 frameworks.
Sustainability and knowledge sharing	Compliant	Outputs released as open-access resources under FAIR data principles.

5. Recommended Mitigation Actions

1. Insert an explicit statement in the Methodology section confirming informed consent and adult participation.
2. Add an explicit declaration of the Creative Commons licence for all co-creation materials.
3. Extend inclusion and accessibility testing in upcoming Workshop 3 and Handbook V2.
4. Add reference to Ethics Advisor oversight and D7.7 in Introduction or Conclusions.
5. Register minor ethics issues (recruitment, accessibility, IP) in WP7 Ethics Issue Register.

6. Overall Ethical Acceptability

Criterion	Evaluation
Adherence to EU Ethical Requirements	High (Compliant)
Data Protection & GDPR	High (Compliant)
Informed Consent	Full compliance
Equality & Inclusion	Moderate – to be expanded
Transparency & Open Science	High
Final Ethical Verdict	Acceptable – Green/Green

7. Conclusion

Deliverable D1.1 aligns strongly with Horizon Europe ethical principles and the OPENVERSE Ethics Framework. Its participatory and human-centric approach exemplifies ethical innovation practice. Minor refinements, explicit consent reference, licensing clarity, and accessibility expansion, are recommended for Version 2 (D1.2).

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