D2.5 – The Roadmap for Open and Co-created Virtual Worlds (V2/M36)

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Abstract	This Deliverable builds on the first version of the OPENVERSE Roadmap, itself based on a wide array of OPENVERSE contributions, including the technology foresight of Task 2.4. It has been enhanced through a series of inputs and updates, including dedicated workshops, an expert survey, and insights from converging initiatives. The final result of Task 2.5 is therefore meant to communicate and co-create stimulating visions of the future, together with a set of actionable policy recommendations on what the EU needs to consider regarding virtual worlds and the future Web 4.0.
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EXECUTIVE SUMMARY

OPENVERSE Roadmap 2.0 sets out how Europe can build open, human-centric and co-created virtual worlds while strengthening competitiveness and digital sovereignty. Drawing on 36 months of research, testing and dialogue, it translates European values into practical choices for policymakers. The OPENVERSE Roadmap outlines strategic directions, key actions, policy recommendations and a framework for continued learning and governance, which is offered to guide further initiatives within the context of the European Union Virtual Worlds and Web4.0 industrial and policy developments.

How the OPENVERSE Roadmap 2.0 was built

The OPENVERSE Roadmap draws on five complementary streams of evidence:

- **OPENVERSE results across tasks and work packages**, which provide a consolidated knowledge base on the technologies, markets, standards and policy levers relevant to virtual worlds. Detailed in a full annex to D2.4/1, they are summarised here and inspire several of the proposals.
- **A technology foresight exercise** (four workshops, >40 experts) that developed three contrasting futures for 2030, additional insights specific to 2040, and a preferred European "ambidextrous" track balancing innovation and proportionate governance. These insights anchor the Roadmap's choices and timing.
- **Two stakeholder co-creation workshops**: the first, held on 16 October 2025 with 48 participants, led to Roadmap 1.0 and was essential to gather feedback from diverse sources; the second, held on 2 July 2026 with 38 participants, prepared the update. Together, they helped validate priorities, instruments and progress markers.
- **A specialised survey**, sent to our list of experts and completed by 52 people, who could not attend the 2 July workshop.
- A public Summit marking the culmination of the OPENVERSE project, held in Brussels and online on 10 September 2026, which included a full session in which experts discussed the Roadmap.

The strategic backbone

The evidence starts with **five mutually reinforcing pillars** that connect policy intent, inspired by the original proposal published by the EU in July 2023, and represent a series of **"must-have" concerns** about virtual worlds from the EU perspective:

- **Pillar A – Trust and Safety by Design.** Users will not stay without safety; makers and builders will not invest without clarity. Building on the measures the EU has already enacted and deployed, the Roadmap promotes safeguards that are effective in practice, 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: a continuous concern to advance and strengthen. 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. Some sectors (e.g. healthcare, education, smart cities, industry) may play a pioneering role in terms of operability.
- **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 (DIHs) and coherent financing pathways (EIC, InvestEU, EIT, ESIF), while using

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public procurement to create first markets increasingly geared to interoperable, accessible and scalable solutions.

- **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, drawing on the actors and use cases gathered by OPENVERSE and by related initiatives such as the Virtual Worlds Association.
- **Pillar E – Foresight-in-the-Loop.** Regular scanning, tripwires, and annual refreshes are anticipatory practices that keep policy agile and cumulative, ensuring lessons from concrete deployments feed back into standards, funding, innovation, and further guidance for others.

From evidence to action

Chapter 4 translates the five pillars into ten Key Actions (KAs), with impacts, indicative leads and timelines. They update the 2023 initiative with priorities on sovereignty, professional deployments and environmental footprint. Skills and interoperability standards are often considered as immediate enabler, while from a broader adoption, financing consolidation and sector-scale outcomes tend to follow, but for the policy recommendations, a genuine and effective prioritisation rationale is proposed (section 5.4), which translated these pillars and actions into enactable measures.

The ten actions are summarised below and developed in Chapter 4.

- **KA # 1 — *Culture, creativity and social life***

The EU must reinforce creator-centred pipelines, maker-led workstreams and aligned skills systems to sustain XR/VW innovation. Motivated creative communities across sectors and borders are the core strategic asset for Europe's virtual-world future.

- **KA # 2 — *Professional-grade applications***

The EU must shift from entertainment to high-value XR/VW uses—digital twins, industrial XR, smart cities and human–machine collaboration. Building ROI-driven, sectoral testbeds and flagship initiatives is essential for technological sovereignty.

- **KA # 3 — *Key standards and interoperability***

Open, measurable interoperability standards for avatars, assets, identity and data formats are a strategic necessity. Coordinated EU–global action and incentives are required to counter proprietary pressures and ensure sovereign deployment.

- **KA # 4 — *Innovative partnerships (science-industry, PPP, cross-border)***

The EU must scale cross-sector, cross-border science–industry partnerships and community-driven collaboration models. Strengthened pipelines (HE/DEP/EIT/ESIF), DIHs and PPPs are vital to build value chains and counter US venture dominance.

- **KA # 5 — *Innovative financing schemes***

The EU needs a coherent, navigable funding continuum to overcome structural gaps for SMEs and start-ups. A public-to-private financing chain is essential to move beyond pilots and enable real scaling in XR/Virtual Worlds.

- **KA # 6 — *Individual and organisational skilling in the digital age***

The EU must address persistent talent shortages with modular, continuous upskilling across technical and functional roles. Retention, financing and alignment of skills with deployment and partnerships are urgent as AI accelerates demand.

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- **KA # 7 — *Societal stakes (trust, ethical, social & environmental issues)***

Virtual worlds raise major societal risks—trust, cybersecurity, misinformation, privacy, divides and environmental impacts. EU guardrails must be strengthened while preserving enough freedom for creators and companies to innovate and scale.

- **KA # 8 — *AI integration***

AI now drives front-line creative enablement in XR/VW, requiring AI-literate creators and robust safeguards. Regulation must be paired with capacity building and open innovation to harness fast-evolving GenAI and embodied AI.

- **KA # 9 — *Geo-political stakes' watch and governance***

The EU's XR/VW strategy must integrate geopolitical dynamics shaping tech competition and digital governance. Continuous anticipatory governance is needed to balance protection and promotion through diplomacy and alliances.

- **KA # 10 — *Sovereignty issues and phasing***

The EU must reduce dependence on foreign actors across the tech stack through phased, long-term sovereign strategies. Investment in niches of excellence and dynamic value chains is essential—"a marathon with many sprints."

How actions become feasible

For each KA, **key steps** across five practical categories (**technologies; products/applications; markets; capabilities; regulation/stimulation support**) are envisaged both as channels of progress for relevant VW practices and as synergies to promote, helping policymakers and practitioners follow the sequence from standards and tooling to finance, procurement and uptake. This "actionability check" clarifies dependencies, time horizons and progress markers. Finally, to make the key actions real levers, they must also be confronted to the hardship of international competition and the hurdles associated with the current context, conflictive and little open to regulation, with cybersecurity, misinformation and hybrid war issues, making sovereignty endeavours in the digital and AI arena both urgent and difficult.

Policy recommendations

To translate these actions, themselves based on the 5 pillars reinterpreting the July 2023 EU strategy for virtual worlds, into concrete actionable instruments, we recommend **6 specific policy actions**:

1. **Concentrate on a) public-value niches with real pull and b) key areas of excellence .**
2. **Promote partnership financing aimed at creating real added value.**
3. **Boost sovereignty and independence.**
4. **Focus on AI support to boost XR/VW for public-value innovation.**
5. **Engage in negotiations and alliances to enhance the governance outreach of the EU digital ecosystem.**
6. **Leverage our three scenarios and their ambidexterity claim to prepare for the next challenges.**

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The Roadmap as a living document

The concluding chapter of the document provides considerations on the future of **the Roadmap as a living instrument, to be taken up by relevant XR/VW players** once the OPENVERSE project ends**.** This keeps policy responsive to technological, market and geopolitical shifts without losing direction.

The Roadmap is now embedded into the OPENVESE Observatory, available as a virtual asset at this link https://observatory.open-verse.eu/virtual-worlds-roadmap

What changes for policymakers

The 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 and real chances for ROI and scalable solutions.** 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 **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 robust regulatory framework), **but outcomes will depend on execution**: moving with agility from general principles to standards that vendors can implement, demonstrators that users can adopt, and makers who can count on consistent financing rounds to scale up. 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**.

The world is changing fast, and the EU has a twofold duty: 1) to deploy defensive measures that help citizens and organisations active in the digital arena (here, in XR and VW) remain aligned with European values; and 2) to launch promotional initiatives that support virtual-world makers of all kinds (technologies, applications, services, communities of practice), so that the EU can cope with today's, and hopefully tomorrow's, fiercely competitive context.

In sum, **OPENVERSE Roadmap 2.0 provides a reference framework for policymakers, with clear policy recommendations on the fast-changing field of XR and VW**, seen from the perspective of European interests, in order to enhance its strategic autonomy and digital sovereignty.

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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	Decentralised Autonomous Organisation
DEP	Digital Europe Programme
DGA	Data Governance Act
DIH	Digital Innovation Hub
DMA	Digital Markets Act
DoA	Description of the Action
DPIA	Data Protection Impact Assessment
DSA	Digital Services 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	European Union
FRAND	Fair, Reasonable, And Non-Discriminatory
GDPR	General Data Protection Regulation

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GPAI	General-Purpose Artificial Intelligence
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 THE MAKING OF THE OPENVERSE ROADMAP 2.0

1.1 OBJECTIVES OF TASK 2.5 AND DELIVERABLE 2.5

Among the tasks that Inspiring Futures, as Task 2.5 leader, had to carry out with its OPENVERSE partners under the DoA, a set of requirements is worth stressing (detailed in D2.4. OPENVERSE Roadmap V1.0). As of October 2026, they can be summarised as follows.

Building on the inputs of three previous OPENVERSE tasks (T1.1, T2.3 and T2.4), with nine workshops advancing this continuous work and involving over 200 experts in total, on the contributions of OPENVERSE partners (some 12 OPENVERSE task contributions, detailed in D2.4) and on other converging EU projects and activities, Task 2.5 has allowed us to construct a stimulating roadmap for the strategic course of action the EU should consider for virtual worlds and Web 4.0, with supporting policy recommendations.

This summary of how the DoA was implemented for this Task, consistent with the approach and format of this final Deliverable (deliberately shorter and focused, building on the extensive preparatory work that preceded it), is essential to:

1. avoid repeating construction details and inputs that served the Roadmap-building process but are not needed to outline and communicate the key ideas meant to help policymakers take virtual worlds to the next stage, in the interest of the EU[1];
2. ensure that the Roadmap and the policy recommendations it proposes can be easily grasped, discussed and used;
3. present this concise result in a format that facilitates its uptake by relevant stakeholders in the virtual-world arena, as a living and sustainable document[2].

Designing this document as a strategic tool able to evolve dynamically, as the environment in which virtual worlds must prove their value changes, involved a dual assignment: on the one hand, to produce a document linked to clear actions (workshops, webinars, survey) traceable within the OPENVERSE project; on the other, to make it a sustainable "product" in its own right, involving relevant external players as needed. For brevity, the first assignment is kept to a minimum, the second being the real objective of Task 2.5.

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[1] Readers interested in how the Roadmap was progressively developed should refer to the first-stage Task 2.5 Deliverable (D2.4, Openverse Roadmap V1.0, issued on 31 October 2025).

[2] The Roadmap is embedded into the OPENVERSE Observatory as a virtual asset. However, discussions within the Consortium and with Commission representatives suggested extending this plan to other possible forms of uptake, for instance being embraced within the future work and plan of action of the Virtual Worlds Association.

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1.2 THE FUNDAMENTALS OF A ROADMAP AND ITS ESSENTIAL OBJECTIVES

In our context, a roadmap is a metaphor that borrows, on the one hand, from the idea of a geographical journey that needs to be formally planned, with essential features and supporting indications, and, on the other, from distinct functional and constructive characteristics[3].

In particular, co-creating the OPENVERSE roadmap meant examining, defining, and documenting the steps toward the goal, with enough leeway to specify the conditions for real progress toward **a strategically engaging objective, despite various hurdles**. The purpose of a **roadmap such as ours is thus to identify actionable levers that can push the domain forward in the most suitable way (bringing it, at each conceivable step, closer to the goal), in the short term but also with early consideration of longer-term challenges, including any "black swans" we may have to cope with[4]. These levers can then be jointly translated into actionable policies.**

Let us recall that in our case the goal has been defined by a series of official Commission documents on virtual worlds and Web 4.0, published since 11 July 2023. Alongside these came key regulatory measures in the digital sphere, the emphasis on the Digital Single Market set out in the well-known Letta report, and the broader economic urgencies identified in the Draghi report.

A roadmap must be precise and consistent enough, step by step, to show the way forward and how it will deliver, yet broad and flexible enough to accommodate complex and even unpleasant aspects of contemporary reality. The recent arm-wrestling triggered by the recent shifts in international relations, in which digital and AI innovative developments and regulatory endeavours represent central points of friction, has made these initial references even more important. Sovereignty issues may need to be balanced and phased over time against values such as a commitment to responsible, respectful, transparent, human-centric, and inclusive digital behaviour. In other words, a roadmap must also be a pragmatic tool, able to hold its own amid diverging or even adverse initiatives. The same applies to the financing of digital innovation and to its environmental footprint.

Our roadmap must therefore define clear, ambitious objectives that fit both our specific focus and the broader societal goals pursued by the EU and the Member States, with a constructive vision of how virtual worlds will contribute to them. Further work beyond this initial proposal, which by nature would have to be co-defined among several key stakeholders, would also need to consider carefully the intermediate steps that show whether we are progressing in the expected direction and, if necessary, offer corrective options.

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[3] For the details, see D2.4, Openverse Roadmap v10 (31/10/2025).

[4] Although OPENVERSE is not, strictly speaking, a technological topic (previous tasks in the project have shown the importance of non-technological factors in shaping virtual worlds), its focus remains strongly tied to understanding, following and assessing the diverse technologies that make virtual worlds consistent and attractive. Methodologically, it is therefore worth citing the seminal special issue of the journal Technological Forecasting and Social Change, "Roadmapping: From Sustainable to Disruptive Technologies" (Linton, Walsh 2004), whose ten articles tackle this challenge from a variety of angles, concerns and epistemological perspectives and can inspire similar work, even twenty years later, in an emerging domain like virtual worlds. The main underlying schemes proposed are, on the one hand, how technologies, products and markets (in the broad sense) are built into innovation dynamics and, on the other, the innovation life cycle with the stakeholders involved: research, development, capabilities and regulatory requirements.

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1.3 A TWO-STEP PROCESS, DIFFERENT MISSIONS FOR ROADMAP 1.0 AND 2.0

Why a two-step process for building a roadmap? We first wanted to create a proposal based on the OPENVERSE consortium's contributions, then gather as many insights and as much feedback as possible. In this sense, version “2.0” signals our intention to strengthen the Roadmap through a diversity of expert sources, responding directly to the analysis and questions from the first stage.

The first Deliverable, which concluded with the Roadmap 1.0, reports in detail the contributions of relevant OPENVERSE partners and results of specific tasks, outlining our own journey from T1.1 to T2.5. To avoid repeating this long account, we produced a dedicated summary of the OPENVERSE contributions and a shortened version of our own foresight exercise and its results.

The two-step process also allowed us to distinguish clearly between our first update of the EU’s initial July 2023 view on virtual worlds and, one year later, a version that better reflects what has happened since in a fast-changing world, affecting the objectives and even the very notion of virtual worlds, as we shall see (the renewed value of XR). With the pervasive surge of generative AI and the coming of age of agentic AI, together with the failure of some key virtual-world players (e.g. Meta) to turn virtual worlds into the new stage of the Internet, as claimed in 2022, priorities and main domains of application have also shifted: from an avatar-based, 3D, headset-mediated digital world to a series of different “verses” in which utility, professional needs and profitability have emerged as the main success factors.

The first workshop was an exploratory step, with Roadmap 1.0 meant to generate interest and corrective ideas. As things developed, with changes (examined in more detail below) that also affected the virtual-world arena, Workshop 2 and the actions we undertook around it turned the exercise into an update as well. With a foresight-in-the-loop perspective clearly open to the future, Roadmap 2.0 is not a snapshot or the end station of a particular Horizon project, but a living document whose value can extend to whoever uses it in the coming years, with a special attention given to the recently established Virtual Worlds Association (VWA) which has been created to implement the EU vision on the future of Virtual Worlds and the Web4.0 and its dedicated Strategic Research & Innovation Agenda.

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2 THE ROADMAP AS A SYNTHESISED KNOWLEDGE BASE

2.1 THE BUILDING BLOCKS OF INSPIRING FUTURES' ACTION ON THIS TASK

In a nutshell, the preparatory work leading to the first and second versions of the Roadmap can be represented as follows:



Figure 1: A schematic/synthetic view of the steps and type of work leading to Roadmap 1.0 and 2.0

Familiarisation

The first step, in 2024, involved screening 117 virtual worlds and retaining 75 for systematic analysis, with 30 deep dives using 10 key criteria and 29 factors, all available in a report (not a Deliverable, but available for consultation). On the one hand, it allowed us and other OPENVERSE Consortium partners to arrive at a short list of 8 virtual worlds for co-creation exercises; on the other, it gave Inspiring Futures first-hand insight into the key characteristics of the virtual-world arena, namely:

1. The strong dominance of US and, to a lesser extent, Asian companies, particularly in virtual worlds linked to or developed in the wake of the video-game industry.
2. The scarcity of open-source and interoperable solutions.
3. The diversity of virtual-asset valuation models, with or without blockchain-based applications.
4. A target audience that is, broadly speaking, young or even very young.
5. The small number of truly operational and attractive virtual worlds capable of delivering professional-level services.

Deepening

The second step of our Roadmapping journey aimed at more precise insights into key issues:

- what these virtual worlds could really do, and in which application domains, including a first look at the fluid boundary between extended-reality applications and virtual worlds, and confirmation that professional applications were scarce and economically marginal;
- the paradoxical state of standardisation: on the one hand, a call for more interoperability and recognised technological standards; on the other, a de facto proliferation of standards (hundreds) across all relevant domains;
- the kind of support, in terms of funding sources and schemes, that SMEs and start-ups would need to become more entrepreneurial and able to scale.

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Futuring

The foresight sequence consisted of designing contrasting scenarios for two horizons: 2030, very close and immediately relevant to the Roadmap, and 2040, meant to raise other types of issues likely to become major stakes by then. To give the scenarios enough distinctive features to represent different policy choices, experts involved in our foresight discussed 20 key questions, technological and non-technological, during the four workshops. These questions and the related discussions can be found in Deliverable 2.3. Such preparatory work provided the knowledge base needed for a roadmap that conveys the past, present, and future stakes of virtual worlds in line with EU needs and values. We called the result Roadmap 2.0 not only because it improves on a first formulation, but also to stress the variety of expert sources mobilised to achieve it. It is also worth emphasising that, in developing this strategy, Inspiring Futures could count on contributions from its OPENVERSE consortium colleagues for several key insights, some already planned in the DoA, others emerging along the way.

2.2 OPENVERSE CONTRIBUTIONS FITTING THE ROADMAP REQUIREMENTS

The Task 2.5 roadmap was not written in isolation. It stands on three years of OPENVERSE work (research, experimentation and dialogue) designed to make a fast-moving topic "decision-ready". Deliverable 2.4 drew on 12 different OPENVERSE topical contributions, fully inventoried and described in an extensive dedicated annex.

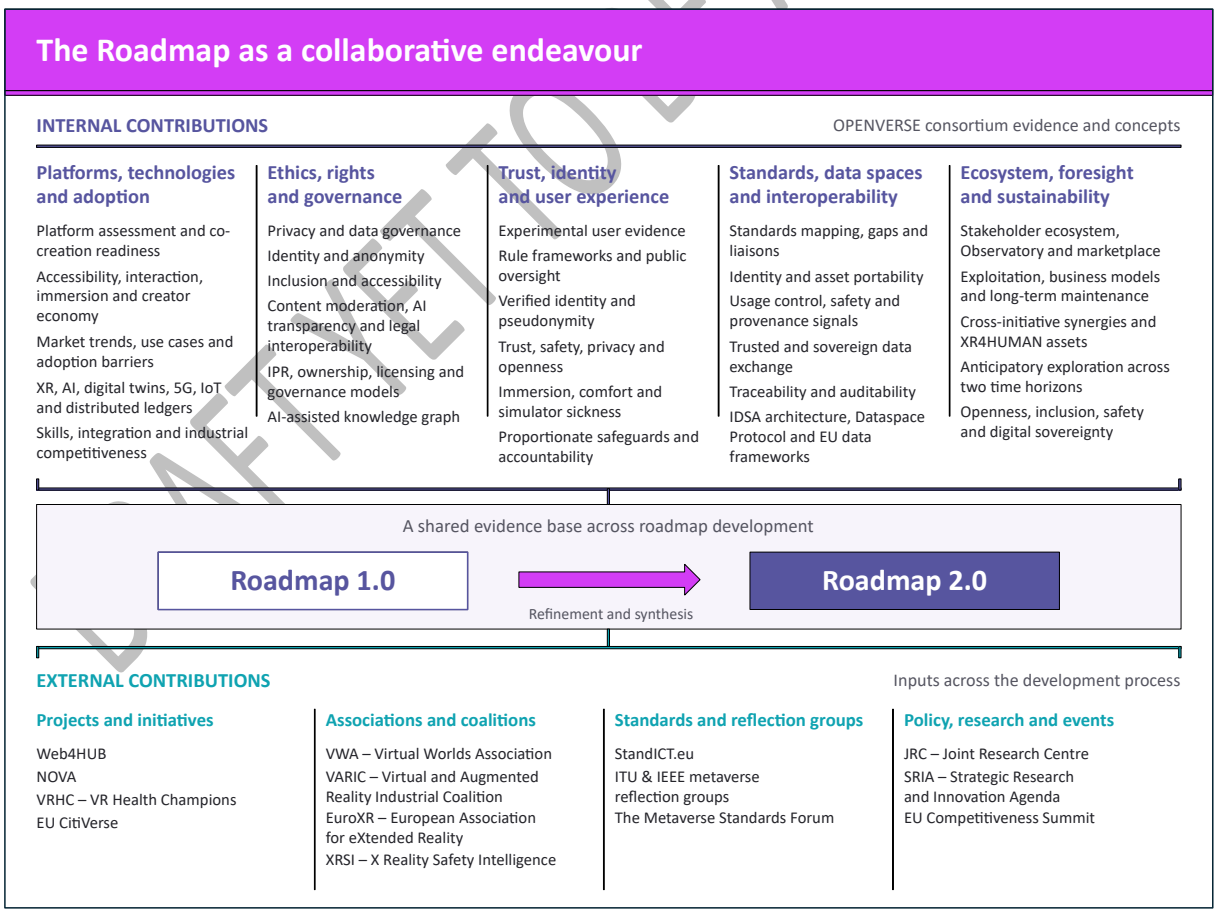


Figure 2: An overview of inputs from OPENVERSE Consortium members and from other projects/initiatives

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This collaborative work, presented above as an overview that is by no means exhaustive, continued during 2026. It involved an update of the trend analysis; a review of what other programmes, in particular national initiatives, had been doing (notably the 136 cases identified by OPENVERSE WP5); reflection on technological developments that the EU was leading in its own way; and, again, consideration of how SMEs and large corporations could converge and cooperate to build the next stage of virtual worlds in a fast-changing world[5].

Although, compared with the detailed account of partner inputs in our first Deliverable, we have summarised these contributions as far as possible here, we must stress a dilemma we faced regarding the WP5 tasks. Besides inventorying national XR/VW initiatives across Europe, WP5 and its leaders were tasked with designing, developing and explaining what a technology framework could contribute to the project's objectives. This began by establishing the relationships that relevant technologies might support for key dimensions of the OPENVERSE mission: 1) enhancing user experience and efficiency, 2) the level of operational interoperability, 3) the innovation and scalability involved, and 4) standardisation and compliance, together with a first inventory of technological capacities. As the framework approached a range of (very essential) needs from a technological perspective, its authors structured it as connecting technology architecture with virtual-world trust, compliance and participation, value and sustainability. Taken a few steps further, this meant an ambitious, systematic identification of technologies either essential to XR/VW ("immersive technologies") or deployed across the digital landscape with a significant impact on, or support for, XR/VW ("core technologies, infrastructure and applications"), linked to governance, ethics and societal integration, i.e. identifying challenges for virtual worlds. By mapping all these elements and connecting the different categories of factors and stakes for different configurational and perspective reading, a full-fledged technology framework was produced and proposed.

Given that the aim was to foster internal collaboration, one may wonder why we did not make more use of this important achievement. In fact, the two endeavours need to be considered as complementary and the Technology Framework can be a resource for customising the roadmap. Indeed, while the end-product of WP5 is an impressive diagram, complex and probably, as such, not easy to apprehend without an introductory explanation, when it comes to customising the Roadmap in specific domains and practical arenas, the Technology Framework, through some parts or as a whole, depending upon the challenge and the objectives, can become an effective navigating instrument to adapt the Roadmap broad recommendations for more specific solutions.[6] [7]

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[5] In 2025, it was suggested that the Roadmap should play a "unifying" role for OPENVERSE's diverse outputs. To this end, all the contributions mentioned above have been deliberately handled in a synergy-seeking perspective, stressing key convergences and valuing cross-fertilisation whenever relevant to the Task 2.5 goal.

[6] Another research future for the Technology Roadmap would be to compare it to some of the numerous similar attempts that already exist to inventory and map technologies making today the digital landscape, or specific parts or domains of applications within that large arena and see how it can nurture or be enhanced by others.

[7] Over the same period, with Roadmap 1.0 in hand (accessible through the OPENVERSE Observatory Wiki we integrated further inputs and insights, thanks not only to our own activities but also to other players linked to other projects, specialised associations and topically relevant EU initiatives, as suggested in the figure above.

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2.3 BUILDING ON TASK 2.4: THE TECHNOLOGY FORESIGHT EXERCISE

Foresight was our remedy for 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)

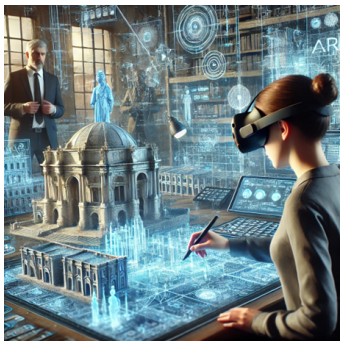
		Key characteristics: ▪ **Flexibility vs. predictability:** Adaptive governance must still provide legal certainty and investment security ▪ **Decentralisation vs. accountability:** Dispersed governance risks incoherence without clear coordination structures ▪ **Innovation vs. integrity:** The line between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

Figure 3: The Architect's Dilemma (scenario # 1)

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 4: 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 5: *Echoes of the Past* (scenario # 3)

To bridge the foresight exercise and the roadmapping needs, we derived a preferred track from these three scenarios; in other words, an ideal scenario (not a middle way but an optimal combination of our initial sources), as follows:

- On regulation and innovation, **emphasising an ambidexterity requirement[8], with a plural and evolving governance grammar**, based on flexible narrative tools that mediate between complexity and choices.
- **Targeting both human-centric and market-oriented expectations**, **supporting SMEs while collaborating with emerging champions**, continuing to learn the rules of the entertainment strand while **developing more professional XR/VW applications**, and remaining agile and future-sensitive rather than fixed, at constant risk of obsolescence or external domination (e.g. interoperability as an industrial learning and leveraging process).
- **Building on European strengths: not only the Digital Single Market but also the most competitive sectors and value chains, science–industry collaborations, PPPs, dynamic communities of practice, pioneering regions and cities, and the diversity of social and cultural life.** This means 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 spaces **should, in policy terms, lead to incentivised co-innovation ecosystems.**
- **New financing mechanisms should strengthen existing instruments, and open innovation schemes should complement strict IPR objectives**, to boost the effects of the EU strengths mentioned above, **involving a diversity of XR and VW designers and makers,** whether as entrepreneurs or as communities.

This “ideal scenario”, the result of intensive expert co-design and co-validation, serves as the initial threshold for the roadmapping work.

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[8] 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 THE 2026 INPUTS THAT ENHANCED ROADMAP 1.0

2.4.1 Continuous watch by Inspiring Futures

During the foresight exercise and the two subsequent roadmapping workshops, a series of open questions emerged, leading us to see them not as weaknesses but as strong signals of multidimensional change in the virtual-world context. Something had changed and was increasingly affecting our topic: something that was neither in the original plan of the EU's July 2023 document on virtual worlds nor in the OPENVERSE DoA, but that could no longer be ignored.

What, then, has really changed that might affect our domain? We identified different types of developments, influences and even shifts that, taken together, exert contextual pressure on our topic. Here are the key factors, events and changes that surfaced and may change how we need to put virtual worlds in perspective:

- Some major **virtual worlds declined or had to make important shifts**, such as Somnium Space, Pixiland, The Sandbox, Habbo, Hyperfy, IMVU, Sansar, Horizon Worlds and Second Life, to mention but a few, and the blockchain valuation of virtual assets came to a halt[9], while some very popular virtual worlds simply **shut down** (e.g. Mozilla Hubs, Rec Room, AltspaceVR, and Sansar, among the best-known players.
- **Meta lost tens of billions of dollars in its metaverse venture** (which will clearly not be the next stage of the Internet). This is worth stressing because it happened to one of the main promoters of the metaverse narrative in 2022, which is now clearly redirecting its efforts and investment towards AI (Muse).
- Non-gaming, non-event/socialising **virtual worlds, i.e. those with more** professional**/industrial objectives (B2B2C), never reached the same level of profitability** as gaming virtual worlds (we will come back to the use of VR for training).
- **Headset sales plateaued** at around 170 million units[10] with 22 million headsets shipped in 2026, while smart glasses seem to replay Groundhog Day again and again (Meta, Google, Apple and others periodically come up with quite interesting systems, but these seem to encounter the same problems as their predecessors: cost, technological limitations, sensory issues and, above all, privacy problems for see-through devices[11]).

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[9] Solutions which did not find their clients: Eight Web3 Game Studios Shut Down in 2026, with big losses (The Web3 Game Over Screen: Eight Studios Shut Down in 2026 as a $15 Billion Bet on Token-Native Play Implodes).

[10] $87 Billion Market — Virtual Reality (VR) Statistics & Facts 2026 Business Stats. Let's stress that the evoked number is a maximum (total number of headset that have been sold and that are still usable), while the number of users is lower, and the number of people occasionally involved in XR/VW activities clearly above (if we follow our T1.1 evaluation, we are in the hundreds of million users for occasional users), meaning that a lot of people actually engaged in XR/VR practices do not necessarily use headsets.

[11] E.g. Apple Vision Pro sold far below expectations, and Sony paused PSVR2 production in 2024 owing to weak demand. However, XR device shipments grew 44.4% in 2025, driven almost entirely by smart glasses (IDC), and Meta sold 7 million Ray-Ban Meta AI glasses in 2025 (EssilorLuxottica). Yet, when weighing these promising figures for XR activities, this surge must be set against the billions of laptops and smartphones able to offer AR/VR performance in their own terms. In any case, the 2021–2024 period projected a mass-market VR/AR revolution that did **not** materialise (VR headset shipments collapsed in 2025, –42.8%).

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- US and Asian players remain dominant, but **the virtual-world arena seems to have lost investors' interest to AI**, in a context more complex and uncertain than ever.
- More important for European skills: **XR has not lost ground to VWs** (the reference persistent, 3D, avatar-based applications) **but, on the contrary, has regained momentum for its versatility and broad range of uses, and in most policies.** European initiatives such as the Flagships 1) on smart and sustainable cities and communities (Citiverse, DEP) and 2) on digitally replicating the human body (European Virtual Human Twin, Horizon Europe), or the multi-country European Digital Infrastructure Consortia (EDICs), support the idea that there is more room for an XR working perspective than for a VW[12] one.
- The big shift European players must negotiate: markets are now the missing middle. The hardest gap is not technology, but creating value-added services that can scale. Thus, although venturing into gaming and socialising virtual worlds may be necessary to build skills, European players need not copy or try to catch up with US and Asian competitors; instead, they should build on European strengths linked to real value-added products and services.
- **AI, hardly a factor in the XR/VW landscape in 2023, has become the major game-changer**: in 2026, there can hardly be any creative solution, major breakthrough or effective market penetration without it. Until 2023–24, discriminative AI (in the form of embedded functionalities) helped operators optimise client relationships through resource management, cutting-edge algorithmic attention, security supervision, ethical framing and anomaly detection. Since 2023–24, **generative AI** has increasingly helped creators with design, avatar management, scenarios, brand revamping, games, events, community communication, etc. Now, on top of these layers, specialised GenAI solutions, agentic developments and the embodiment of AI in vehicles, devices, infrastructures, manufacturing automation and smart robotics will take XR/VW to the next level.

2.4.2 The second workshop (2 July 2026), the expert survey and the Summit

On 2 July 2026, the second workshop of the OPENVERSE roadmapping sequence brought together experts to provide feedback and insights on possible update needs.

The questions addressed interactively during the workshop were the following:

Table 1: OPENVERSE Roadmap V2.0 — 2 July Workshop, interactive session

What we asked (questions only, not results) live on Mentimeter · single plenary track

#	What we asked	Format	Options / scale
1	In one word: where do you see the most realistic value for European virtual worlds over the next three years?	Word cloud (multiple entries)	Free single words
2	With the single, all-encompassing "Metaverse" having stalled, where should the EU now concentrate?	Multiple choice (up to 2)	Focused XR niches · industrial/commercial/educational · a broad multi-track "x-verse" · one interconnected European VW · other

[12] "Virtual world" is taken here in the strict sense, involving persistence, 3D and some type of avatar, which an XR ecosystem does not necessarily need, as is often obvious in domains such as city-management simulation, industrial automation or healthcare training. However, an important point raised in our first Task 2.3 workshop is the possible transition of a functional XR solution towards a VW format if needed.

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#	What we asked	Format	Options / scale
3	Should the EU first reduce its digital dependencies, build on existing areas of excellence, or pursue both?	Multiple choice (single)	Reduce dependencies first · build on areas of excellence · both (where possible)
4	Which niches are most worth European investment now?	Multi-select (up to 3)	Industry/manufacturing · healthcare · education/training · culture/media · security/defence · urban/digital twins · other
5	Which dependency most urgently needs to be reduced to give Europe deployment capacity?	Multiple choice (single)	Cloud & edge · specialised AI chips · AI/LLM development · headsets · data & data-flow operators · interoperable standards · other
6	On balance, is generative and agentic AI for Europe's XR & virtual-world niches more a risk or more an opportunity?	Scale (slider)	Mainly a risk ↔ mainly an opportunity
7	Is professional adoption held back more by funding, by lack of capacity to produce an ROI, or by technological constraints?	Scales (three sliders)	Rate each — lack of ROI capacity · lack of funding · technological (sovereignty) constraints — Less relevant ↔ more relevant
8	Is regulation, on balance, more a brake or more an enabler on European XR / VW competitiveness?	Scale (slider)	Mainly a brake ↔ mainly an enabler
9	Using the Roadmap's Actionability Check, what is the single biggest gap holding back the actions you care about?	Multiple choice (single)	Technologies · products & applications · markets · capabilities · regulation/stimulation support
10	Of the Roadmap's ten Key Actions, which are genuinely make-or-break?	Multi-select (up to 2)	The ten KAs (VW skills · ethics & well-being · cross-sector partnerships · CCI/media models · open standards & sandboxes · AI + creative skills · professional adoption · sovereignty & IPR · creator financing · environmental footprint)
11	What is the single most important action the Roadmap is missing, and under which Pillar would it sit?	Open ended	Free text (+ Pillar)

[A closing audience slide — "What questions has this session raised for you? Add them here so we can continue the discussion" — invited open questions to carry into the panel and the continuing consultation.]

To keep this document proportionate, the results are not presented as such here but are integrated directly into Chapter 4, in the Roadmap's inventory of actions to be justified and undertaken.

In principle, the two-step process planned in the OPENVERSE DoA was to use Roadmap v1.0 to gather feedback and thereby enrich our understanding and our capacity to formulate policy recommendations. To this end, OPENVERSE chose a wiki application accessible through the OPENVERSE Observatory. After several rounds of improvements to see whether the wiki changes would increase its attractiveness and generate usable comments, we concluded it would not deliver the insights we expected for Roadmap v2.0. In April 2026, we therefore opted for a parallel information-gathering channel: we invited our list of experts (some 200 who had taken part in our workshops until then) to complete a survey reproducing the questions on the wiki. We obtained 52 answers from those experts who could not take part in Workshop 2.

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The questions asked on the wiki (Roadmap for Open and Co-created Virtual Worlds - OpenVerse Wiki), and therefore also in our survey, to obtain insights for Roadmap 2.0 were the following:

Table 2: OPENVERSE Roadmap 2.0 — Stakeholder & Expert Survey

What we asked (questions only, not results), open on EUSurvey until end August 2026, with 52 respondents.

#	What we asked	Format & response options
Section A:	Respondent profile	Name & e-mail; primary role; main sector of activity; country/region; organisation type; availability for 2 July workshop.
Section B:	**Strategic orientation for European virtual worlds**	
B1	Sovereignty or areas of excellence?	Single choice — A) reduce digital dependencies & deficits first; B) build on already-strong capabilities and areas of excellence; C) pursue both where possible.
B2	Which dependencies must be reduced as a priority to gain deployment capacity?	Select up to five of 20 — e.g. cloud & edge, specialised AI chips, hyperscale data centres, AI/LLMs, data-flow operators, headsets, quantum, video games, telecom backbones, rare earths (+ other).
B3	Which areas of excellence should Europe build on?	Multi-select of 12 — healthcare, industry, security/defence, environment, education, socialising/events, culture, games, tourism, sport, media, urban/digital twins (+ other).
B4	Which technical building blocks matter most?	Multi-select of 20 — e.g. WebXR, 3D web-native/AI-aided, WebGPU, NeRF (+streaming), open formats & sovereign interoperability (glTF, OpenUSD), Gaussian splatting, progressive streaming, scene-management standards, territorial digital twins, 5G–6G (+ other).
B5	Cross-disciplinary skills & synergetic partnerships	Open text — exemplary use cases from science to economic application.
B6	Funding issue or technological one? Rate each lever	Importance matrix — 18 levers (avatar quality, ease of interaction, on-device compute, interoperable standards, SME seed funding, ROI evidence, PoCs for replication, scale-up finance, partnerships, ethics-aligned rewards…) on a graded priority scale (Not a priority → Top priority) (+ open: any priority missing?).
B7	The case for optimism (AI in XR/VW)	6 statements on a 5-point agreement scale (Strongly disagree → Strongly agree; "I am not sure") (+ open comments).
B8	The case for caution (AI in XR/VW)	5 statements on the same 5-point agreement scale (+ open comments).
B9	Emerging challenges that could reshape priorities	Rate 5 — environmental load, smart robotics, brain–computer interfaces, cybersecurity/fakes, "synthetic everything" — on a graded scale (Negligible → Decisive) (+ open).
B10	Does the EU need a distinct track of its own?	Single choice — A) focused virtual-worlds creative orientation; B) bet on XR proof-of-concept/ROI across several "x-verse" tracks; C) other
Section C	**Reacting to the Roadmap v1.0**	
C1	Priority of each of the 10 Key Actions	Graded priority rating (Not a priority → Top priority) for all ten KAs, grouped by horizon — immediate (KA2,3,6,9), medium (KA1,4,5,7), long (KA8,10).
C2	Which Key Action is most at risk of not being delivered?	Open text — name the KA and explain why.
C3	Actionability Check — the single biggest gap	Single choice — Technologies; Products/applications; Markets; Capabilities; Regulation/stimulation support.

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#	What we asked	Format & response options
C4	Any critical action missing from the ten?	Open text — what, and under which Pillar and horizon it would sit.

[Purpose: to validate and update Roadmap v1.0 towards version 2.0 — testing the sovereignty-vs-excellence balance, the dependencies and building blocks that matter, the funding-vs-technology question, the optimism/caution balance on AI, emerging challenges, and the priority and completeness of the ten Key Actions. Full option lists are held in the survey instrument.]

As with the results of Workshop 2, and to keep the document concise, the insights obtained have been integrated directly into Chapter 4's detailed roadmap inventory of actions.

The third element we relied on to improve Roadmap v1.0 was the OPENVERSE Summit, held in Brussels on 10 September 2026, with both in-person and online participation. The Summit, whose primary goal was to present the project's results to a broader audience, gave Inspiring Futures the opportunity to organise a panel session fully dedicated to the Roadmap, with first-class speakers who commented on it and expressed their interest in it.

The Summit provided opportunities to enrich our Roadmap; its insights are integrated directly into Roadmap 2.0, in Chapter 4. This was possible thanks to the whole Summit organisations in its attendance, but even more so thanks to a specific dedicated session which Inspiring Futures organised so as to obtain as much feed-back as possible on the Roadmap (that at that point we could call v"1.5").

Beside the moderator, Dr. Gianluca Misuraca and Dr. Pierre Rossel, Vice-President and President of Inspiring Futures, who presented the state of advance in the Roadmapping process, the session allowed discussing the Roadmap thanks to the other presenters and discussants of the panel, in two rounds of interventions, the first one involving the panelists' presentations of their activities and their view on the session's topic, the second one a series of questions prepared by the moderator. These distinguished contributors were:

Camille Donegan, CEO, Eirmersive

Patricia Pons Tomás, Researcher, Instituto Tecnológico de Informática (ITI) Valencia

Kathrine Fremming, Head of Cultural Partnerships, Khora

Matthieu Worm, President, Virtual Worlds Association[13]

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[13] Worth mentioning is that, as part of Task 6.2 on the sustainability of OPENVERSE' main assets, which the Roadmap is a core achievement of, a further dialogue session was organised with VWA representatives on October 26, 2026, as a step to nurture future collaborations, soon to be followed by the Virtual World Association forum of Nov. 2-3, 2026 and the UNITEDXR conference of Dec. 7-9, 2026. Each one of these events constitutes an immediate opportunity to deepen, specify and focus with these partners on what is the most needed way to use our contributions in line with future EU challenges.

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Fig. 6: The Panel of the Summit' session dedicated to the Roadmap

This session and more broadly, the Summit, punctuated the sourcing activities that we gave ourselves to enrich Roadmap v1.0 to its final version (v2.0).

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3 FROM EVIDENCE TO ACTION: FIVE PILLARS FOR THE ROADMAP

What is the idea behind the notion of “pillars”? Strictly speaking, they are neither actions nor policy recommendations. They represent the absolute “must-have” legacy of the EU’s original July 2023 proposal on the future of virtual worlds, adapted to the current situation.

What, then, should Europe actually do today that captures the spirit, if not the precise wording, of the concept the EU launched three years ago? To connect the “must-haves” advocated then with the new proposals of the next chapter (the Roadmap 2.0 formulation), this projection must build on firmly reaffirmed and established values that cannot be bypassed: a threshold of concerns converging on five mutually reinforcing pillars. Each pillar is described below in prose rather than lists, so that the logic is easy to follow while technical accuracy is preserved. These five pillars can also be seen as guidelines for putting the Roadmap to use.

3.1 PILLAR A — TRUST AND SAFETY BY DESIGN

If people do not feel safe (in terms of privacy and integrity protection) and secure (in terms of cybersecurity), they will not stay; if builders lack clarity, they will not invest. However, if everyone is concerned only with preserving safety and trust, innovation can be stifled. This first pillar therefore calls for all these requirements to be aligned. The lesson from our own experiments is to make safeguards visible, proportionate, flexible and open to learning. This broad set of criteria also includes establishing and promoting robust cybersecurity principles to protect virtual-world infrastructure and user data from threats. To give weight to this intention, the Roadmap should encourage provenance and transparency signals for synthetic and AI-assisted content; standardise moderation and “amendability” patterns, so that harmful material can be removed with an audit trail; and build accessibility and inclusion into the definition of “ready to deploy”. The policy instruments here are sandboxes and reference implementations tied to procurement: a city or hospital buying 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. That said, the whole “Trust and Safety by Design” approach should always be weighed against the need not to stifle innovation, as a development-minded guardrail.

3.2 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 scratch each time. Work on standards should start with identity and asset portability, consent and usage control, and policy expression and enforcement signals, while the data-spaces community provides the substrate. The Roadmap therefore also emphasises the need for 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. Success here means fewer brittle integrations and more repeatable ones: more profiles published, more conformant vendors, more cross-platform asset transfers and shorter onboarding times. The USB-C precedent could be reapplied to a pressing need where it might make a difference, but European standards specialists should be the ones to make such proposals, for a quick change for the better through enforcement.

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3.3 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 of 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 that may also have to evolve, becoming proactive rather than merely reactive, so as not to leave all funding opportunities on European soil to American venture capital). Procurement 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 runs on EU-based infrastructure. Several of the Roadmap's Key Actions will need to follow this pillar's mindset to become sustainable.

3.4 PILLAR D — SCIENCE–INDUSTRY TESTBEDS FOR STRONGER COHESION AND ADOPTION

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

3.5 PILLAR E — FORESIGHT-IN-THE-LOOP FOR BLENDED POLICY OPERATIONS

Finally, the governance of virtual worlds and Web 4.0 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. An Observatory can become an operational memory: a public place where profiles, conformance results, playbooks and KPIs are published, and where a "change 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 how readily buyers and builders adopt those updates. Foresight is not only about regulation: it should do more than foresee and follow up, and proactively recommend decisive, even urgent, inroads, such as support for European gaming engines or boosting infrastructure for specific application domains (e.g. 5G–6G for health, smart cities and industry). Foresight should also help people leave their comfort zone: for European industry, for instance, using the future to broaden its mindset and experience regarding investment, risk, science–industry alliances and international collaboration, including with non-European players, so as to move gradually towards a more proactive deployment of skills and excellence[14].

[14] One way of doing that is to build on European projects but also on national initiatives (136 such activities identified by OPENVERSE WP5).

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4 THE ROADMAP AS A GUIDELINE WITH KEY TARGETED ACTIONS

4.1 DEFINING GOALS, VISION, ISSUES, ACTORS AND STEPS

4.1.1 Introduction

We have considered the complexity of a roadmap for virtual worlds and Web 4.0: it is not a manufacturing plan with a fixed sequence of steps producing a workable result, but a construction involving several actors and factors to make the goal more accessible, concrete and likely to prevail.

Here we can underline a basic difference between a foresight exercise and a roadmap. A foresight exercise helps stakeholders and, ultimately, decision-makers prepare for different futures, seen as a fairly open field of possibilities, strengthening immediate or future decisions against a complex and uncertain context. A roadmap, by contrast, is the set of means, resources and combined steps that may allow us to reach a goal already more or less defined as desirable. Both exercises are nevertheless useful and potentially complementary. In our case, the ideal scenario mentioned in Section 2.3, the result of our own foresight process, can be seen as a stimulating and challenging interpretation of the goal the EU is pursuing. It can enrich the formulation of that goal with a broad-lens view of what may happen and (positively or negatively) affect it, along the way or later on.

To ensure that all these inputs fit in the right place and at the right time, we must define our tools and notions, and how they are configured, in view of the goal.

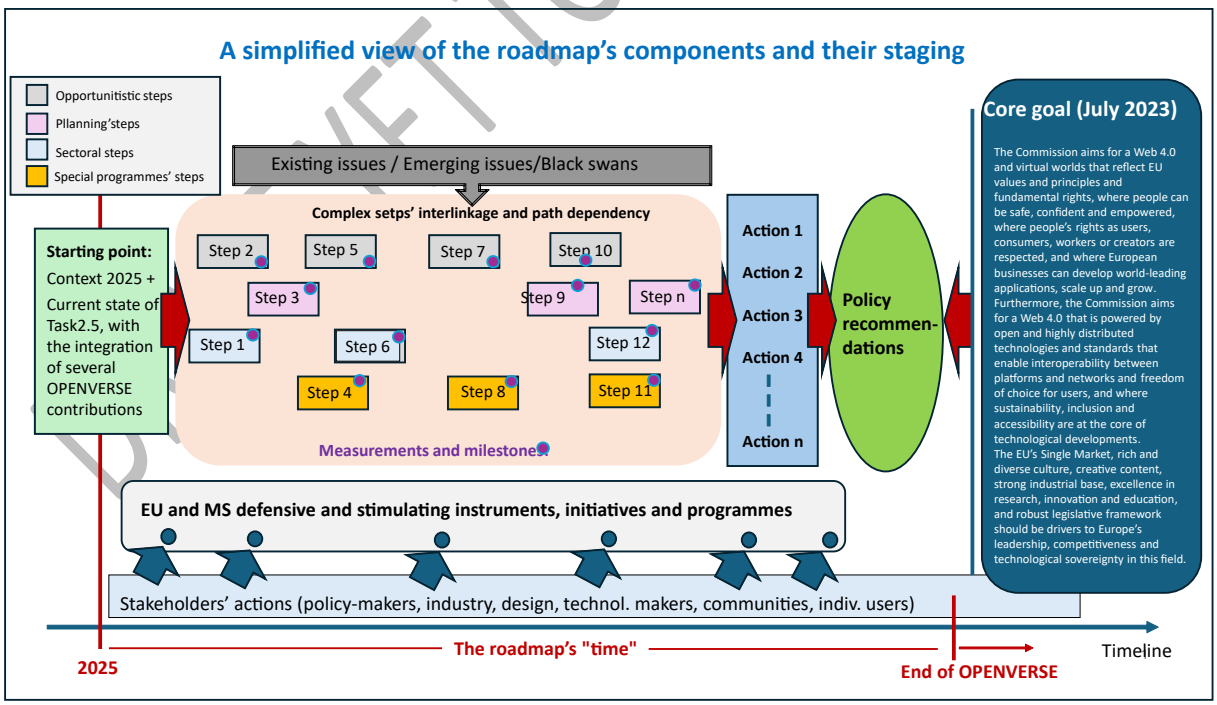


Figure 7: A simplified view of what a roadmap is, with its building steps and factors

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The figure above shows schematically all the components that must be made cohesive, meaningful and effective, so that they can be specified through a structured vision and building process: the Roadmap, anchored in the present and targeting the future, and therefore somehow different from the core goal of July 2023, with some persistent values.

Let us examine these different components, this time not in the abstract but anchored in the EU's strategic needs regarding virtual worlds and Web 4.0.

4.1.2 The Roadmap's Goal

As a brief reminder, in 2022 the notion of the "metaverse" was becoming hot, amid controversial announcements and comments, and the EU responded by producing its own concept, defining the objectives to be attained on its own terms.

Following a series of workshops with over 100 stakeholders from late 2021 to mid-2023[15], the European Commission launched the Virtual and Augmented Reality Industrial Coalition, bringing together industry and policymakers on 14 September 2022. The Commission then published a new strategy on Web 4.0 and virtual worlds to steer the next technological transition on 11 July 2023.

This seminal work included a first compact formulation of a strategic goal:

> "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 powered by open, 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 statement is expected to 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

[15] In this formative context, early approaches to the problem we tackle include 1) the European Parliamentary Research Service report on metaverses (Madiega Tambiana et al., 2022), which raised concerns about competition, data protection, liability, financial transactions, cybersecurity, health, accessibility and inclusiveness, and 2) the analysis of the pros and cons of extended reality produced for the European Commission by Visionary Analytics, Idea Consult (2022).

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- Boosting the EU's technological capabilities
- 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 SMEs 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 EU's goal for virtual worlds and the Web 4.0 challenge is then translated into ten key actions, which we return to at the end of this document to assess whether they still serve as effective guiding recommendations for 2027 and beyond.

4.1.3 The Roadmap's Starting Point

Our starting point is, of course, our diverse sources and inputs:

- All the EU documents produced after the seminal document of 11 July 2023, including the rich work carried out by the JRC (*De Hont I. et al., 2023, and Abendroth Dias et al., 2025)*, which showed the promising sides of virtual worlds for EU development; and, more generally and in the same spirit, the recent EU **2025 Strategic Foresight Report** (The European Commission, 2025d), not focused on, but nevertheless relevant to, virtual worlds**.**
- Other studies and reports on this topic have been published since the summer of 2023[16].
- All relevant inputs from OPENVERSE partners across their tasks, as presented in Sections 2.1, 2.2 and 2.3.

The roadmapping undertaken in Task 2.5, of which Deliverable 2.4 was a preliminary expression before this final one in autumn 2026, is therefore built on all these inputs, used, configured, and aligned with all other components meant to advance the EU towards its goal.

4.1.4 The Steps Towards the Goal

As this is not a strictly ordered plan, as a manufacturing or dam-building plan would be, we show the steps as intervening at successive moments in time, but only loosely interconnected. Of course, when you zoom in on a particular linkage or sub-objective, more binding pathways can emerge.
What matters here are the different kinds of steps that should be considered, at a minimum, as depicted in the diagram below:

[16] This list also includes the recent report by Virtual Dimension Center, Perey Research & Consulting (2025) on most, if not all, protective regulatory instruments for the digital world and for virtual worlds in particular.

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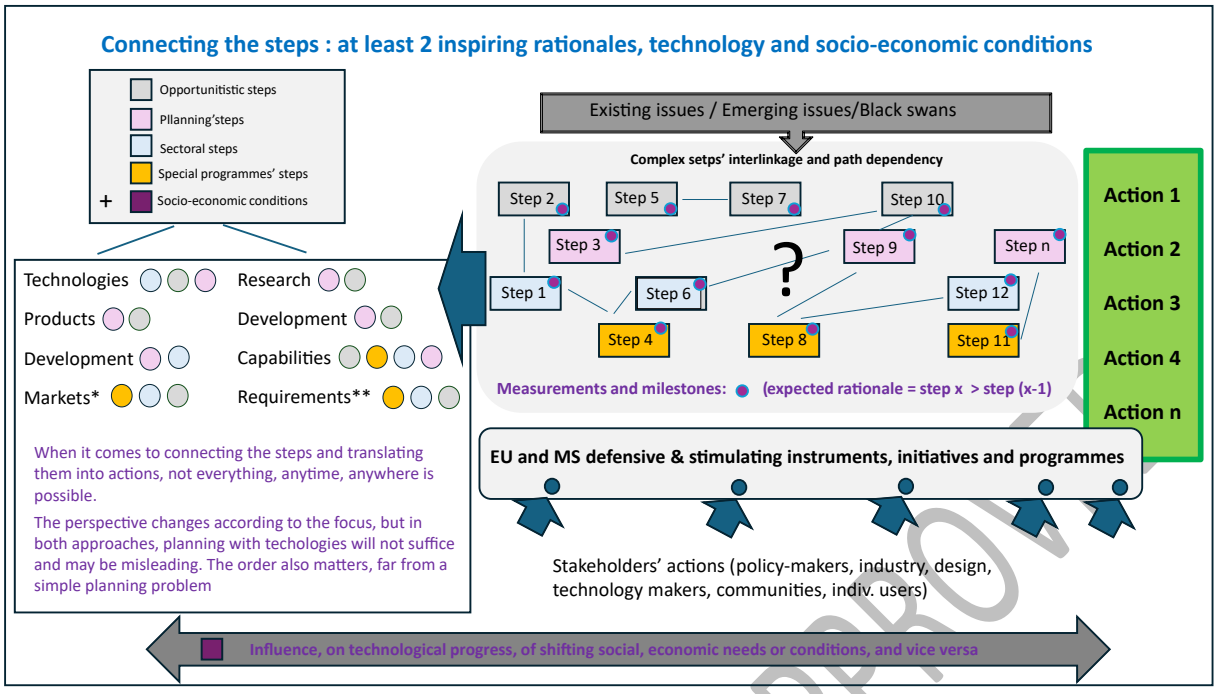


Figure 8: Multiple ways and influential factors to connect the dots

- **Opportunistic steps**: steps that may represent a real change but were not planned, simply seized as they emerged. In a complex and uncertain context, this can happen at any time and is typical of serendipitous agility.
- **Planning steps**: by contrast, these steps are planned and take place as the momentary expression of a sub-objective that prefigures the final goal on its own terms. The roll-out of the AI Act is a typical example. Given the complexity of our topic, the set of planned steps may involve tightly as well as only loosely connected steps.
- **Sectoral steps**: some sectors naturally have their own agenda and may sometimes move faster than the overall objective, under the pressure of context or innovative initiatives. Healthcare (and mental health in particular) or defence, for instance, may act as accelerators.
- **Technological steps**: in a domain like virtual worlds, technology clearly plays an important role, and its progress largely determines what is possible at a given moment. This also has limits, as the marketability or profitability of technological advances must demonstrate their effectiveness. Symmetrically, technology opens new avenues, while other times new needs, economic conditions, or specific societal concerns pave the way for technological progress.
- **Special programmes' steps**: at some point, there may be a need to regulate a problem not originally linked to virtual worlds that has become a component of their development, while still being treated according to its own rationale and specific underpinnings. This is the case, for instance, of MiCA and other blockchain-related regulations, which have become increasingly important for valuing virtual assets in the real world. Cybersecurity is a similar example.
- **Synergetic steps**: the actions of a roadmap should never be treated as separate running lanes or silos, but connected to one another in multiple ways. These synergies make the difference between painstaking effort and positive strategic resonance, with actions designed to deliver a little more than they are supposed to. Following Linton and Walsh, 2004, these are "connecting the dots" steps, following different rationales that are more complementary than competitive.

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Paying attention not only to the actions to be undertaken but also to the building steps that help each endeavour and initiative resonate with others to create new capacities will allow us to meet our ambidextrous objective: attending to the market on **one side** and to **requirements (or regulations) on the other**. This ideal is not the miraculous output of wishful thinking; we must construct it. The interconnection and synergy we stress here, in this multi-rationale arena, amount to a gradually acquired, sustainable, and resilient **collective capability.**

Finally, the steps to target may also be seen as gaps to overcome. Here we must distinguish 1) gaps continuously redefined by hostile actions or even innovations, as in cybersecurity; 2) gaps that are currently difficult to close, such as interoperability objectives, but where partial progress may already mean a lot; and 3) gaps that are realistically expected to be put behind us within a certain time (upskilling, professional virtual-world developments, SRIA-type coalitions competing at the highest level, etc.). Regarding gaps, some upcoming steps may make a difference, provided adequate supporting instruments, including for financing innovation, are in place and stakeholders are determined and ready on time.

Two shaping influences, already analysed in our foresight study, will make a strategic difference for deploying and effectively leveraging most of these instruments: the Draghi and Letta reports (both published in 2024), which show that markets and their socio-economic underpinnings are critical to building sustainable ventures.

Let us see how these different factors and levels of influence may interact in a roadmap focused on XR/VW:

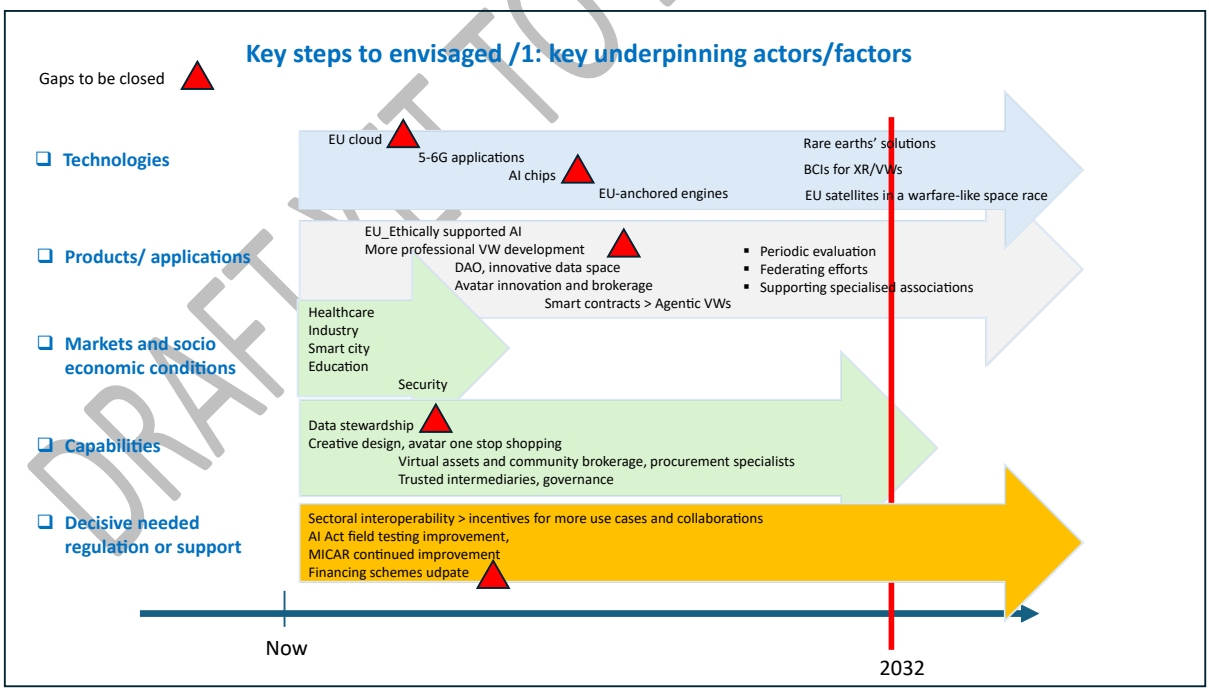


Figure 9: A first tentative outline of the steps that can make the process credible and actionable

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The diagram above shows how the factors on the left, introduced in the previous diagram, may trigger concrete and promising steps that bring the ecosystem as a whole closer to the goal (relatively speaking, of course). Let us now see how these factors can interact to build stronger capabilities, through four examples selected among many possibilities, simply to give an idea. This knowledge base would nevertheless resemble the kind of monitoring dashboard that policymakers deploying the Roadmap and the recommended policies would need to translate into a series of deep dives, with effective measurable markers.

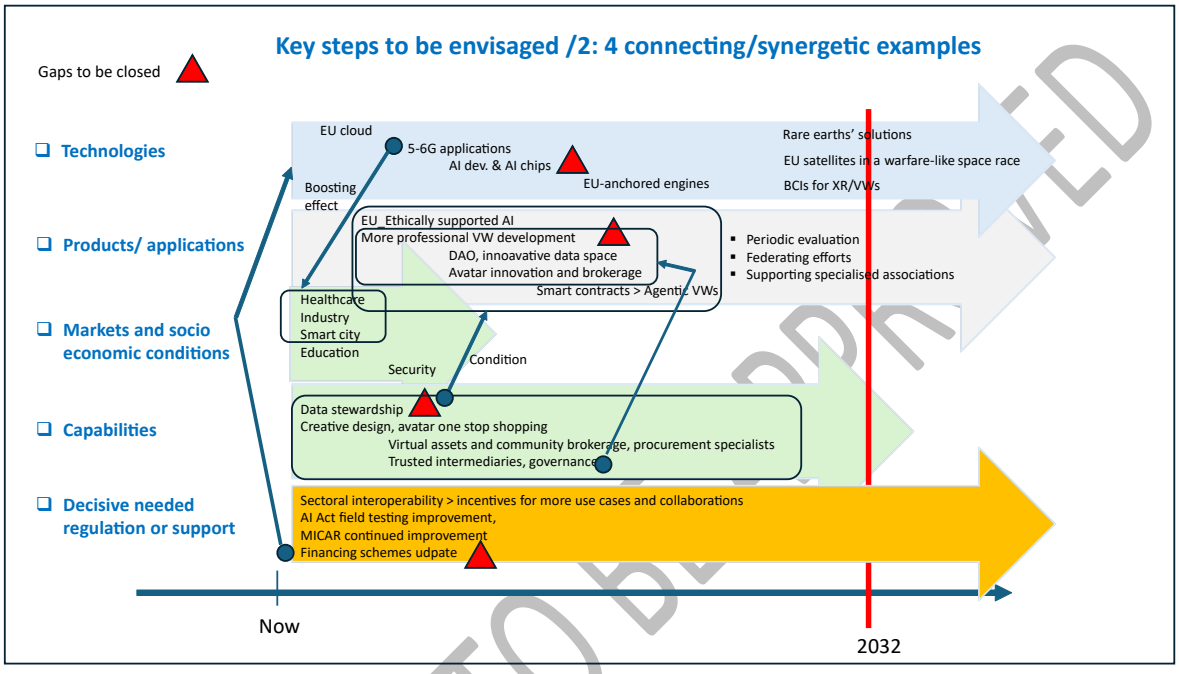


Figure 10: Four examples of how different factors can/should combine to produce more impact

4.1.5 The Different Stakeholders and Their Potential Role

Table 3: 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, XRSI	Define and maintain interoperability standards, certification schemes, and data governance frameworks; enable alignment with digital-twin and data-space protocols.
Large Industry "Champions"	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.

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Associations & Industry Coalitions	The Virtual Worlds Association (VWA), 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.

All stakeholders are important, but even more pressing is the need to generate creative dynamics: policymakers and private-sector decision-makers have a duty to enlist, stimulate, facilitate, mobilise and support all the actors of the XR/VW field needed to create the conditions for positive change. New performance levels, initiatives and applications will come from makers of all kinds who are not only motivated but encouraged to deploy their efforts, individually and/or as communities, despite adverse forces and hurdles, towards much-needed areas of activity. Novelty for its own sake matters less than reinforcing existing strengths; individual creativity matters less than collaborating and federating creative endeavours; being trained and skilled matters less than deploying expertise that enhances networks, value chains, partnerships and the transfer of applications from one domain to another area of need. Mindset is key: multiplying rather than adding, combining talents rather than stand-alone performance.

In this context, one category of stakeholders often receives too little attention: associations and groupings linked to XR and VW developments. These associations, events or coalitions may be European or international in the broader sense (with all the risks now highlighted by legitimate sovereignty concerns), but they are important arenas for collective learning. They tend to bridge different specialities, geographical anchors, organisational sizes, target application domains, and business models; the only threat arises when one of them claims to be indispensable and unique to capture entrepreneurial motivation. This intermediation can extend to sub-specialities of makers serving makers with a narrow focus (a type of avatar, for instance), alternative financing offers or community-based propositions. In all cases, diversity is a strength (in this sense, Table 3 above is only the first step towards a broader inventory of European forces). In this forward-looking perspective, at our Summit on 10 September 2026 and throughout the final stretch of the project, particularly in our efforts to make OPENVERSE assets sustainable, we clearly identified **the Virtual Worlds Association (VWA)** as a key player that could usefully relay and enrich our own efforts in the years to come[17].

[17] As the original plan was to use the OPENVERSE Observatory (OpenVerse Observatory | Mapping the Future of Virtual Worlds) to host and promote the Roadmap, we keep this idea intact, but address the future of this instrument in the last part of this Deliverable, aptly titled "Futures".

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Another type of stakeholder to emphasise is the "champions": large players within the European perimeter, existing or soon to acquire that status, who can claim to compete at the highest level worldwide and relate directly or indirectly to virtual worlds. During our foresight preparation (Task 2.4), we identified such potential players and, although the list is not exhaustive, arrived at a diversified group[18] of more than 20 champions. In the next step, i.e. between the two Task 2.5 workshops, we took a deep dive into this category, not only to examine its collective capability but also to explore how these large companies could complement SMEs and VR/XR/VW associations, as the advocated SRIA project (for **Strategic Research and Innovation Agenda)[19];** is currently encouraging in the European VW landscape (see: The European Partnership on Virtual Worlds - Open Verse).

That said, we advocate the following approach: policymakers and their operational agents, from top to bottom of the socio-political scale, should expect every stakeholder to take its share in stimulating, framing and supporting the contributions of all other players. No one is meant to do it alone; rather, everyone has a duty **to motivate and enable others to do it**.

4.1.6 The Time Issue

A key issue of our topic is that time is itself a variable of the problem to be addressed, if not "solved".

First question: when should the EU goal for virtual worlds outlined in 2023 be attained, and how can we even tell when it will be? The first part raises the issue of a time horizon by which success or satisfaction could be ascertained, and so far we have no idea when this might be. The second part calls for indicators to rely on, to get our bearings and feel confident about where we stand during the roadmapping process. For the first part, even without a precise date, we can keep a qualitative benchmark in mind, such as: "if, five years from now (i.e. 2030–32)[20], we have not made the kind of progress that documents attainment of 80% of our expectations, we will have a serious problem (lagging behind, losing control, etc.)". In addition, for some other issues, such as the development of brain–computer interfaces (BCIs) and their possible future role in virtual worlds (some already perceptible)[21], and in other domains such as 6G or quantum computing, longer-term targets must be considered.

Second question: how can we "roadmap" something effectively when the goal is not fixed in time or verifiable? Time horizons help guide energy and action. However, setting time objectives and deadlines should be a matter for policymaking; we suggested the urgency of each action, and the result is that most are either urgent or need continuous monitoring and improvement.

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

[19] Besides EU support, the association's founding members are worth mentioning: Siemens, SAP, VRT, CNRS, CNR, KU Leuven, Fraunhofer, DFKI.

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

[21] Inspiring Futures has just finalised a study on the future of BCIs (publication forthcoming). The notion of the nervous system is clearly broad, extending beyond the brain as an organ, and as the trend is towards less invasive systems, virtual-reality and haptic devices and applications, at least from a healthcare perspective, already play an important role, providing data that can in turn help improve the performance of more invasive systems.

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Third question: the situation has changed considerably since 2023 (more uncertainty, EU digital compliance caught in the crossfire of broader geopolitical negotiations, difficulty in building a cohesive EU front for existential industrial redeployment, new social and environmental doubts, and a massive, fast-spreading misinformation context)[22]. Should we keep the goal as formulated or update it? And if we update it (the option we chose), in which direction?[23]

What makes timing even more critical is that industry actors outside Europe, such as Meta, Apple, NVIDIA, and Epic Games, not to speak of Chinese competitors[24], 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 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. These questions have no definitive answers; their value lies in being asked assertively and periodically.

4.1.7 Towards Metrics that Allow Stakeholders to Evaluate Progress

Consider the following back-propagation rationale: attaining the EU goal requires a series of effective actions, which in turn presuppose steps that build the pathway of progress. Active stakeholders support this by using specific means, generating innovative applications, coping better and better with key issues, and making the best of available opportunities. This is the story suggested by Figures 6 to 9. To work, this backcasting process must be checked and validated by convincing metrics showing that it is not just a story and that, at each step defined as a reference point, the EU and its Member States are getting closer to their goal. Being able to measure and document progress is therefore decisive in building our roadmap. This is why, after stakeholder roles and EU instruments, we dedicated the third exercise of Workshop 1 to this factor.

For measurement, one could, for instance, use the DESI index[25], based on 16 indicators. However, it mainly covers the number of users (lay and specialist), devices, connectivity and the deployment of technology infrastructure, as well as enterprise uptake of cloud services, big data and AI, and SME technological intensity (at least four technologies), together with e-health records and online public services for citizens and businesses. Notably, the index offers no way to assess societal issues, medium-term business profitability, innovation dynamics, or sovereignty.

What is difficult to measure is 1) qualities (quantities are of course easier) and 2) the European value of the transformative processes linked to these technologies. This is why we distinguished quantitative from qualitative markers of progress. **Both are important and, to some extent, interact.** The examples of **quantitative measurements** we proposed to explain the purpose of the exercise are quite ordinary,

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[22] The AI surge alone is a pervasive game-changer: barely perceptible for virtual worlds in July 2023, two and a half years later it massively affects most human activities and organisations, including virtual worlds, in many ways already identified and addressed in building our Roadmap.

[23]The preferred track, or ideal scenario, that emerged from our foresight exercise was conceived with this criterion in mind.

[24] Constantly looking at American applications in the digital domain, we tend to forget the growing importance of the Asian market and, in particular, the rise of Chinese digital players in all relevant sectors, including XR/VW.

[25] Cf. the DESI publication (30 June 2023), in line with the Digital Decade policy programme: Digital Economy and Society Index - Dashboard | Scoreboard profile | Composite Indicators and Scoreboards Explorer

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but must be precisely ascertained: e.g. an increase in the number of users, virtual assets, professional virtual-world applications, virtual assistants, active e-wallets or new talents on the market, AND the kind of changes they generate, with some assessment. The qualitative appraisal criteria we suggested (here we do not speak of measurement) include a virtual-world success that inspires several other players elsewhere, an innovative deployment in a sector (for instance, for the environment or in a specific industry), or access to a library of virtual functions. Siemens provided another series of examples in our foresight workshops: open-standard deployment, new trust architectures, and proactive modular governance tailored to industrial-scale immersive deployments. Qualitatively, this approach dovetails with a broader EU reindustrialisation strategy, although some of these suggestions may also involve quantitative metrics. Again, the observed transformative impact is an essential criterion, beyond simply counting numbers.

4.1.8 Looking for Key Actions: a Goal-Oriented Mindset

No pre-emptive move should short-circuit the value of the expertise collected in our workshops. Still, the process is fairly clear by now. We need to arrive not only at a constructive script linking all the components inventoried so far, but also at an action-oriented formulation. For this, we have the initial proposal of July 2023, with its ten actions, which was assessed to see how things have progressed over the past two and a half years. In addition, given the changes that have taken place, with more stringent sovereignty and industrial development requirements than ever and exacerbated international uncertainty, we paid more attention to growing issues such as 1) the environmental footprint of digital technologies and 2) the pervasive, seamless interconnectivity associated with Web 4.0, with its diverse risks, flaws and divides, not to mention the over-surveillance it may bring.

Another way to interconnect and follow up our Roadmap building components is to frame them within a consistent vision of what must be accomplished, delineated below as a socio-cognitive, technological and economic space to address, sketched as follows:

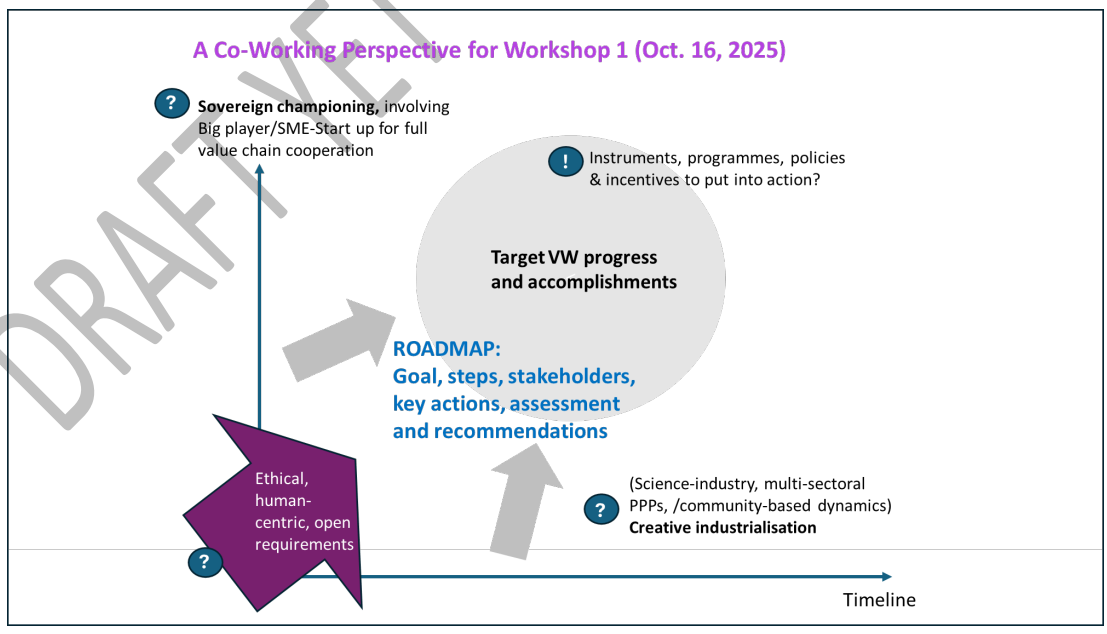


Figure 11: The Co-Working perspective proposed for our T2.5 Workshops

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4.2 ROADMAP 2.0 COMPARED WITH ROADMAP 1.0

From Roadmap 1.0, we retained much as a valuable indication of how things were done, why, and with what expected results, sometimes in simplified form to avoid repetition and reader fatigue, while keeping as much as possible of the structure and underlying reasoning.

The new list of actions (we will show the connections between them, as these actions are not meant to become siloed objectives or practices, and a full matrix might work as well as a list format) involves some changes compared with the first edition (2025). In particular, two actions were merged into one and a new action was proposed (KA # 9). The order of the actions was also changed to reflect how specific each is to XR/VW versus dependent on broader, sometimes entirely external, technological and other factors, from the most XR/VW-specific to the least. This is a useful indication, since not all actions are equally XR/VW-centred, but it by no means implies that the first Key Actions are more important or urgent than the later ones. We chose to present ten actions partly to respect the original format of the 2023 EU proposal and to keep the list easy to examine; we could easily have designed a roadmap with over 30 key actions, which would then hardly be "key". Hence the ten-action format, and the point that they are all equally important. Any priorities (see Chapters 5 and 6) will be defined according to a specific, clearly more policy-minded rationale.

We present the actions in two steps:

- A first, fairly detailed step (below) covering: 1) the needs addressed, 2) the impact each action targets, 3) who should act, 4) the degree of urgency, and 5) the intrinsic/extrinsic ratio, i.e. how far factors more or less specific to XR/VW affect each action.
- A second, more compact and easily grasped step, which can also be used for executive and communication purposes.

Let us now see how the actions proposed for Roadmap 2.0, improved from the previous version based on diverse inputs, unfold. To avoid any misunderstanding: KA stands for Key Action and, as in the previous version, there are ten of them (with their 2025 number shown in brackets).

4.3 THE TEN ACTIONS REVISITED FOR ROADMAP 2.0

KA # 1 (ex # 4): ***Culture, creativity and social life***

- *What is needed?*

The initial objective (EU, 2023) was to help EU cultural and creative industries test new business models in virtual worlds through Creative Europe, with matchmaking between developers and industrial users via EDIHs and EEN to support hubs and uptake. This need, and therefore the supporting objective, is still valid in 2026.

- *What should be done, beyond what exists already?*

- Empower creators and build a coherent yet diversified set of pipelines for skills and innovative endeavours: beyond the crucial role of policymakers, this means envisaging creators as motivated individuals, but mainly through communities of interest and practice, as a means of deploying broad-bandwidth, scalable professional output, with or without AI, and new business models

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building on PPPs, blockchain-related communities and open innovation schemes as much as on classical IPR.

- Establish maker-led workstreams (e.g., for innovative cross-services, but also AI-by-design safety patterns and interoperability artefacts), alongside specialised skills pipelines that attract, train and, critically, retain creative and technical talent on the continent.
- Align 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).

- *Who should do it?*

Beyond Creative Europe, as initially indicated, the media and culture sectors of the EU and Member States, education, related financing bodies, XR/VW associations and business schools should be mobilised. Any new project in this domain will populate and strengthen the dynamic under way[26].

- *Degree of urgency:*

"Yesterday", today and continuously from now on.

- *Intrinsic/extrinsic ratio*

Culture and creativity extend far beyond virtual worlds, but the European future of virtual worlds will undeniably have to be built on the motivation and endeavours of creative people. This focus even lies at the core of what virtual worlds are about.

KA # 2 (ex # 7): *Professional-grade applications*

- *What is needed?*

This is a huge challenge: so far, virtual worlds have developed predominantly in the wake of video games and social media, yet the EU clearly needs more professional virtual worlds and all the supporting applications that can boost them.

- *What should be done, beyond what exists already?*

In line with the Draghi report, a serious approach to the capitalisation and ROI evaluation of XR/VW developments (for proofs of concept and shareable experiments, not just creative, "nice-to-have" ones) is crucial. This means investing in a diversity of approaches, sectors and challenges: not only professional training with VR, which remains attractive, but also digital twins of various kinds for simulation and enhanced human–machine connection and collaboration, city-management developments, and XR for industries such as manufacturing, healthcare, security, agriculture, environment and tourism, at a minimum.

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[26] In this perspective, the European project LIL-echoes (LIVING CULTURAL LABS: EMPOWERING COMMUNITIES THROUGH INTERCULTURAL ENCOUNTERS IN VIRTUAL WORLDS | LIL-ECHOES | Project | Fact Sheet | HORIZON | CORDIS | European Commission), which has just started and combines XR and AI, aims to explore this promising collective capability: an initiative we consider a weak-to-strong signal in the right direction.

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- *Who should do it?*

Flagship projects for smart/sustainable cities (CitiVerse) and the European Virtual Human Twin under HE/Digital Europe; European Digital Infrastructure Consortia (EDICs) in Web 4.0-related areas should be encouraged. More generally: industry players, technology makers, designers, XR/VW associations, education, EU policymakers and Member States, and financing providers.

- *Degree of urgency*

Even though some developments (such as smart robotics or brain–computer interfaces) will take years to emerge and demonstrate their market value, an urgent mindset must be promoted for virtual worlds at large (including all forms of XR): there is an urgent need to build replicable use cases, scaling capacities, and methods to measure performance and productivity gains for a variety of economic stakeholders.

- *Intrinsic/extrinsic ratio*

This need of course extends beyond XR/VW, but it is essential to a decisive shift towards real-economy deployment of all the components, technologies, scientific achievements and industrial applications that broadly match the XR/VW focus. In terms of sovereignty, it is also the only way to "exfiltrate" ourselves from the marginal position, relative to US and Asian players, that prevails in entertainment virtual worlds.

KA # 3 (ex # 5): *Key standards and interoperability needs*

- *What is needed?*

To develop standards for open/interoperable virtual worlds (e.g. for avatars, assets, identity, data and formats), with sandbox options and interoperability measurement criteria. Interoperability has been one of the great stated goals since the beginning (2023), but it seems difficult to achieve in a domain where most platforms promote proprietary concepts of ownership.

What should be done, beyond what exists already?

Across virtual worlds, there are some alliances and commercial arrangements, and blockchain-based monetisation of virtual assets may also include interesting cross-chain options. But the domain will not progress fast enough without strong policy and financial incentives, as the market is centrifugal by nature. Consider briefly Christoph Runde's summary of the ViWisso report[27], presented at our Summit on 10 September 2026 (an exhaustive study on the matter, if ever there was one)[28]: the study compiled some 2,500 records (standards or standardisation processes) produced by 163 organisations, grouped into eight families. Its conclusion is nevertheless optimistic: there is no deficit of standards, only a deficit of coordination, and the lead author concludes that this situation is a very stimulating opportunity for the EU.

[27] Besides his StandICT involvement, Christoph Runde works at the Virtual Dimension Center (Virtual Dimension Center (VDC): Startseite). For more information on the ViWISSO project: ViWISSO - Top Ten Recommendations.
[28] GR ARF 010 - V2.1.1 - Augmented Reality Framework (ARF); Virtual World Standards Landscape Report

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On the interoperability strand, standardisation can be seen as a plumbing necessity. More concretely, in XR/VW, 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. Some sectors (healthcare, education, smart cities, industry) may also play a pioneering role in terms of operability.

- *Who should do it?*

Technology makers and leading standardisation bodies (IEEE, ITU), user communities, and XR/VW associations such as the Metaverse Standards Forum or StandICT.eu are the first stakeholders concerned, but we should also mention European programmes such as DEP (test-before-invest)[29], HE (standards research)[30] and the EU ID/eWallet for identity checks and consent signalling, while identity tokens for interoperable avatars bring credible credentials to virtual-world interactions and transactions.

- *Degree of urgency*

Claimed as a pivotal need since 2023, it remains as crucial as ever, even though it appears to be a long-term struggle (see below). Beyond market forces, incentives might make a difference. New projects dedicated to exploring, testing and implementing solutions are, of course, also welcome[31].

- *Intrinsic/extrinsic ratio*

Technologically speaking, there are thousands of standards in the digital realm, but some are directly linked to XR/VW: 3D content, rendering and asset standards (e.g. WebXR); more generally, XR device, interaction and safety standards covering hardware, optics, sensor fusion, haptics, human–computer interaction and the ethical assessment of extended-reality systems; network and performance standards needed for real-time VR (latency, bandwidth, jitter, QoE); and consistent definitions for tracking, spatial mapping, scene understanding, object recognition and environmental sensing in XR systems, covered in part by IEEE XR foundations and ITU-T XR service definitions. However, this standardisation arena keeps evolving under a double movement: centripetal forces that simplify,

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[29] The DEP's "Test-Before-Invest" programme is part of the *Digital Europe Programme*, offering companies—especially SMEs—access to experimentation facilities, expert support, proofs of concept, pilots and feasibility studies so they can evaluate digital technologies before committing to investments. It is delivered mainly through European Digital Innovation Hubs (EDIHs), which provide labs, assessments, expert panels and digital-maturity evaluations. The goal is to reduce risk, demonstrate ROI, and accelerate adoption of advanced technologies such as AI, HPC, cybersecurity, XR and digital twins.

[30] Horizon Europe's standards-oriented research supports the development, testing and pre-standardisation of emerging technologies so they can be integrated into European and international standards. It funds projects that create reference architectures, interoperability frameworks, testing protocols, certification methods and conformity-assessment tools across domains such as AI, XR/virtual worlds, cybersecurity, data spaces, robotics and digital twins. The aim is to ensure Europe's scientific and industrial innovations become standard-ready, strengthening EU sovereignty and accelerating market adoption.

[31] In this perspective, the newly started TWINE project aims to demonstrate how open, federated and human-centric infrastructures can make such services interoperable, accessible and trusted for citizens, cities and SMEs. TWIN-BASED WEB INTEROPERABLE NETWORK FOR ENGAGEMENT | TWINE | Project | Fact Sheet | HORIZON | CORDIS | European Commission

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bridge systems and validate de facto successes, and centrifugal forces driven by innovation trends and commercial competition.

Beyond this technological diversity, the EU is rightly pushing for interoperable solutions, platforms and virtual assets that favour standards, including through incentives: a crucial stake for the deployment of EU virtual-world actors.

KA # 4 (ex # 3): *Innovative partnerships (science-industry, PPP, cross-border)*

- *What is needed?*

To 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, IPR evidence, etc.). Creators and start-ups should not be seen as the basic units of virtual-world deployment: communities and diverse forms of partnership should be incentivised to channel and help scale the endeavours of creative individuals and young innovators.

- *What should be done, beyond what exists already?*

Science–industry collaborations, such as those supported by the European programmes **HE/DEP/ESIF/EIT**, should be strengthened and regarded as a strong EU asset, in which research support programmes (Horizon, but not only), alongside their Member State equivalents, play a key role, including by supporting and motivating industry to come forward with proposals (the market "pull" approach). The EU can facilitate the creation of testbeds and translational pipelines, with DIHs as entry points for SMEs and the necessary incentives[32], while DEP is essential to provide trust in PPP collaborations.

New cooperation models (PPPs, but also all sorts of community-oriented endeavours, Decentralised Autonomous Organisations (DAOs) and any open innovation initiatives) should be encouraged, despite the hurdles, as a way of taking part in a collective learning journey.

- *Who should do it?*

EU policymakers, industry, research, health, cities, Member States, financing providers and XR/VW associations, along with the European programmes already mentioned.

- *Degree of urgency*

As the gap widens with the level of financing that US players can access, particularly through venture capital, to launch and scale up their companies, we cannot wait: this is an absolute policy urgency.

- *Intrinsic/extrinsic ratio*

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[32] Incentives are also a means of reconciling the requirement for innovation with the compliance "must" regarding European values and regulations. On the need to navigate this paradox, see the article by Meyers and de Streel (2026), also presented at the recent European Competitiveness Summit organised by CERRE (https://cerre.eu/events/finding-europes-competitive-edge-ai-governance-industrial-policy-and-smarter-regulation/).

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As XR/VW does not seem to belong to the long-established value chains developed in mature industrial domains such as machine tools or pharmaceuticals, it has a particular need for additional, synergy-oriented forms of support, rather than simply relying on what the market's "invisible hand" can do.

KA # 5 (ex # 9): *Innovative financing schemes*

- *What is needed?*

The lack of EU venture funding is undeniable and, more generally, there is a gap in access to funding, and probably in innovative mindset, affecting small innovators across the EU and its Member States.

- *What should be done, beyond what exists already?*

The EU is actively trying to develop new approaches to support digital makers, as the instruments examined in our Workshop 1 showed; however, this effort needs to be amplified and generalised. Given the number and diversity of possibilities, what may still be lacking, especially for start-ups and SMEs, is an overall guide on how to better access, deploy, and exploit these instruments.

In particular, a coherent funding pipeline spanning EIC and InvestEU through to private equity, corporate and angel networks, and perhaps additional options (the search for new instruments, approaches, measurement methods and synergy-building endeavours should never stop), is essential to mobilise deployments beyond pilots. Scaling up is the major hurdle most SMEs and start-ups face.

- *Who should do it?*

Existing initiatives and tools that should play a role and converge include: DSM / 28th regime / DIHs / HE / DEP / ESIF / InvestEU / EIT / EIC; DMA / DSA / Cyber Resilience Act; blockchain-related frameworks (incl. MiCA); EU Angels & Private Equity; the EU Savings and Investments Union; and ESIU-type products (European Sovereignty, Innovation and Upscaling financial instruments) to mobilise retail and institutional capital.

- *Degree of urgency*

As for innovative partnerships: waiting means increasing marginalisation.

- *Intrinsic/extrinsic ratio*

We have observed a gap between large companies on the one hand and SMEs and start-ups on the other. Although venture funding is lacking across the digital domain, including AI, XR/VW is particularly short of funds for development and scale-up.

KA # 6 (ex # 1): *Individual and organisational skilling in the digital age*

- *What is needed?*

Let us recall the initial EU 2023 objective: to build skills for virtual-world technologies through Digital Europe, and make the EU an attractive destination for highly skilled non-EU talent. Although the JRC (de Hont et al 2025, and more recently De Prato, 2026), inventoried more than 68,000 organisations

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active in XR/VW in Europe[33], problems remain: brain drain and talent shortages, especially with the surge of AI, with European public and private organisations constantly struggling to cope.

- *What should be done, beyond what exists already?*

European science and professional schools remain of good quality; the problem is how to retain innovators, or help finance them, once they have acquired basic training. This problem is closely linked to the previous ones (funding, partnering, professional application development). Skilling for real ROI and the sustainable deployment of talent and companies depends essentially on making several of our Key Actions synergistic, rather than treating specific problems in silos. AI, as a game-changer (see below), increases both the acuteness of the shortage and the diversity of upskilling needs, for instance for intermediate capabilities (functional specialists)[34] linked to the challenges of data stewardship, innovative procurement, ethical oversight, and cybersecurity or misinformation, which every organisation will have to cope with.

- *Who should do it?*

EU policymakers, industry, research, Member State policymakers and government agents, and specific sectors (industry, health, security, services) should feel concerned and, following existing initiatives (e.g. AISHA), create a full league of members willing to embrace what this constant need for upskilling implies.

- *Degree of urgency*

Not only is this urgent, as the brain drain has been going on for years, but with AI becoming a pervasive tool for most human activities, including those we see as key components of virtual worlds, this need for modular and diversified skilling is likely to keep growing: a problem that AI, as a substitute for human skills, does not seem to solve.

- *Intrinsic/extrinsic ratio*

To be fair, the skills deficit and brain drain mentioned here are not specific to extended reality and virtual worlds (all digital dimensions are concerned), but they also affect this domain and therefore cannot be ignored.

KA # 7 (ex # 2): *Societal stakes (trust, ethical, social & environmental issues)*

- *What is needed?*

This domain of concern has many subsets. Trust is a main pillar, much desired but hardly satisfied today across the whole digital landscape (cybersecurity threats and malpractice, massive propagation of misinformation). Then there is privacy, with the GDPR, and this still leaves other societal problems: digital divides (which challenge the claim of inclusiveness), child protection in particular (but not only), content moderation and, increasingly, the environmental footprint, especially with the use of generative AI in our domain (XR/VW). To these should be added mental-health issues and the

[33] Abendroth Dias, K., Soguero Escuer, J. and De Prato, G. (2026). *Virtual Worlds, Real Impact: Mapping EU Strengths and Global Interdependencies*. Publications Office of the European Union. JRC146046. doi:10.2760/9999772.

[34] See for that constructive notion, REF

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protection, or even prevention, needed regarding addictive behaviours encouraged by the big social media platforms, but also by the gaming and socialising strand of virtual worlds. The EU is doing a lot, but in a troubled world where conflictual moves affect these intentions.

- *What should be done, beyond what exists already?*

What should be done is to pursue what is already being done; but as this is apparently not effective enough, particularly in the current conflictual context, this arsenal of regulatory guardrails should be designed and used in parallel with governance efforts. On the one hand, these must operate at geopolitical scale, as this is typically a global issue (see KA # 9) and not just a sectoral or local one; on the other, all the issues raised in this action also have national and even local roots that must be addressed. Internationally, beyond what the EU can do within its own perimeter, this means studies, negotiations and alliances to establish governance principles across borders and continents: a game of patience and determination. Nationally, there are many possible measures, legal as well as educational (with a wide range of options, from child protection to the struggles of consumer associations[35]).

The only problem with this global–local approach to defensive measures, and it is becoming a real crossroads, is preventing the tightening of regulatory efforts, however necessary, from unduly restricting the leeway innovators need to colonise new spaces, deploy their creativity, and have a chance to scale.

- *Who should do it?*

On the one hand, the same promoters of the regulatory efforts put in place so far in the digital landscape, including at Member State level; on the other, actors at diplomatic level, for governance and related negotiations (see KA # 9).

- *Degree of urgency*

The way the world is evolving calls every day for action, either to strengthen existing regulatory measures or to open new international negotiations, creating a sufficient diversity of alliances to escape isolation (right but alone: the worst-case scenario).

- *Intrinsic/extrinsic ratio*

The problems raised in this section are not specific to virtual worlds: social media, video games and streaming are plagued by the same kinds of threats, risks and flaws. But in this broad arena where private, social and environmental values are hard to protect[36], virtual worlds have their share, which means taking these issues seriously.

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[35] At the OPENVERSE Summit on 10 September, Luis Bravo Martins of XRSI Europe reminded us of this very important and too often neglected social lever, particularly relevant for raising and addressing digital-safety issues and for the ever-present need to build or rebuild trust (recall that "Trust and Safety by Design" is our Pillar A).

[36] Let's never forget that behind the claim of strong European values to be preserved and even promoted, there is a deeper issue of basic human rights.

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KA # 8 (ex # 6): *AI integration*

- *What is needed?*

Until 2023–24, discriminative AI helped operators optimise client relationships through resource management, cutting-edge algorithmic attention, security supervision, ethical framing and anomaly detection, albeit in a way that was opaque to end users. Since then, generative AI has increasingly helped creators with design, avatar management, scenarios, brand revamping, games, events, community communication, etc. What is now needed is, on the one hand, enough AI literacy and even proficiency among creators to use AI for richer, faster-built and better-managed virtual applications and assets; and, on the other, the capacity to cope with the dark side of AI, which can bring all sorts of flaws, from biases and cybersecurity issues to fakes and untrustworthy sources.

- *What should be done, beyond what exists already?*

The AI Act and several earlier EU regulatory measures provide a solid start on the defensive side, though far from perfect, as anyone can see from how the AI-aided digital world is unfolding today. As we shall see in the next Key Action (# 9), this is closely linked to the EU's capacity for international negotiation with its major "frenemies". However, another strand of action is needed: promotional capacity-building of the skills with which AI enables creators, as well as private- and public-sector agents, individually or at organisational level, to perform creative XR/VW tasks. This is more closely linked to KA # 6 and should therefore be seen as part of the same supporting actions and policies.

This last strand of AI uptake should also be linked to open-source, open innovation and DAO-type schemes, as additional co-creation configurations that give EU XR/VW makers, as well as virtual asset managers and brokers, AI creation advisors, avatar librarians, etc., a better chance to boost their performance and achievements.

- *Who should do it?*

Besides the EU measures already in place (AI Act, Data Act / Data Governance Act, CRA), motivated creators should of course help themselves by joining, as mentioned, projects, initiatives and partnerships in which they can deploy their talent. This also involves today's large number of EU and national players (see the initiatives identified by OPENVERSE WP5)[37], public and private, working on AI on both strands of the issue examined here: frontier scientists, industry creators and champions, security specialists, etc.

- *Degree of urgency*

It is hard to imagine anything more urgent, although finding regulatory measures that can really keep up with how GenAI is evolving, while maintaining innovative capacity in today's fiercely competitive landscape, is far from simple. And agentic AI, embodied language models, brain–computer interfaces and smart robotics are arriving…[38]

[37] In this case, the next stage would be to assess to what extent the 136 initiatives identified by the WP5 leaders have integrated AI into their development.
[38] In line with the spirit of this KA, concerning agentic AI envisaged from a consumer's protection perspective, worth reading is Busch (2026).

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- *Intrinsic/extrinsic ratio*

AI is clearly not a challenge restricted to XR/VW: it is everywhere and increasingly perceived by most people as a "common" concern, whatever the activity it supports. However, it is also a particular concern for the XR/VW community and for policymakers trying to navigate the current context, for the reasons described earlier.

KA # 9 (new): *Geo-political stakes' watch and governance*

- *What is needed?*

The preceding actions clearly point to a broader problem, external in nature but with internal implications (see KA # 7, for instance), which we could sum up as follows: even when the focus is the future of European virtual worlds, it is impossible to ignore how global geopolitical forces, linked to a series of technological, economic and political developments, are likely to influence that future. The need is to find ways to engage at these different levels and preserve both values and economic opportunities. We must stress here that the capacity to rely on multilateral organisations to solve problems and gradually reach agreements with others, as a general methodology, has decreased. It is unfortunate, but it is part of the global equation in which we must nevertheless both performance and values.

- *What should be done, beyond what exists already?*

Governance is the word that sums up the needs arising from this observation, as it implies that policymakers and governments at all levels must simultaneously preserve, protect and prevent, and promote, innovate and compete: a series of verbs that hardly go together. Governance here means not a style or a process, but comprehensive and continuous action to keep these various factors aligned in the interest of citizens, taking all factors into account. Negotiation and diplomacy must be paired with diverse regulatory needs and with continuous watch, even an anticipatory mindset (foresight in the loop!), regarding how global and local situations evolve interdependently. Key world players seem to dismiss the multilateral organisations that until now seemed a possible neutral space for such mediation; the situation appears to have changed. Multiple negotiations and alliances are increasingly necessary in a global game where nothing seems wholly isolated from the whole, with constant efforts needed to keep local situations stable and, if possible, improving rather than declining.

- *Who should do it?*

The EU and the Member States, but also NGOs, professional associations and private organisations linked in one way or another to our topic, the scientific community and, if they are still able to mobilise and act, specialised multilateral organisations.

- *Degree of urgency*

Paradoxically, it always seems either too early or too late: the timing of this continuous, even Sisyphean, endeavour is difficult to grasp, but we recommend constant vigilance and readiness in this troubled and uncertain context.

- *Intrinsic/extrinsic ratio*

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The needs and proposals presented for this action are by no means specific to XR/VW, but they are also relevant to it: consider bias moderation requirements, addictive algorithms, cybersecurity and alternative narratives that intersect with our focus.

KA # 10 (ex # 8): *Sovereignty issues and phasing*

- *What is needed?*

A huge share of the data flows generated in Europe is captured directly or indirectly by foreign companies and even governments, and the dependence underlying this asymmetrical relationship seems to be growing as if unstoppable. The need is recognised and translated into precautions and measures to counter and, if possible, reverse this trend. However, the task is gigantic: we are talking not only about the infrastructures and devices directly involved in XR/VW, but more broadly about the global digital ecosystem, i.e. submarine cables, satellites, clouds, rare earths, AI, chips, robotics, data centres and quantum developments, as well as search engines, e-commerce platforms, social media and streaming.

- *What should be done, beyond what exists already?*

Regulatory measures such as the DMA and DSA, the AI Act and other precautionary regulations, several of which were mentioned in previous actions of this inventory, are already helping. However, as noted, several other types of measures are also needed: not only protective or defensive ones, but also measures promoting alternatives (European champions of large, medium or smaller size) and medium-term solutions (for satellites, clouds, rare earths and perhaps chips). Even if started immediately, any measure will take time and fit into a strategy of multiple carefully planned phases, with possible corrections. In the digital arena in general, we need to develop dynamic value chains with good collaborations between champions and major industrial players, SMEs and even individual creators. In our domain (XR/VW, now with the importance of AI), technological capacities seem to matter less (relatively at least) than what happens to the data generated and the business models and exploitation schemes that go with them. Here we are very close to KA # 2, 3, 4 and 5.

- *Who should do it?*

Top-down engagement is indispensable, from the EU and then the Member States, but also from professional associations and communities of makers who can act as listening posts, relaying the on-the-ground realities decision-makers need.

- *Degree of urgency*

The clock is ticking: this will be a marathon with many short sprints along the way.

- *Intrinsic/extrinsic ratio*

Sovereignty is obviously a much broader problem than XR/VW; however, as we saw from the outset of our analysis of 75 virtual worlds, dependence exists and must be addressed. The way to meet this challenge is not to try to catch up but, alongside parallel governance and diplomatic efforts, to invest and innovate in areas of excellence and high-value niches for both the public and private sectors.

Having presented and discussed these Key Actions in some detail, we now propose, for communication and swift policy use, a two-page version of the same inventory.

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4.4 A TWO-PAGE COMPACT FORMAT OF THE SAME TEN ACTIONS

Table 4: The compact action inventory of Roadmap 2.0

Key Action # (ex KA #), short name	Concerns and to-do suggestions
KA # 1 (ex # 4) *Culture, creativity and social life*	• The EU's 2023 goal—helping Cultural and Creative Industries test new virtual-world business models—remains fully relevant in 2026. • Europe now needs creator-centred pipelines, maker-led workstreams, and aligned education–skills–mobility systems to attract and retain talent while enabling interoperable, safe, innovative XR/VW development. • This requires coordinated action from Creative Europe, Member States, cultural and media sectors, education actors, XR/VW associations and business schools. • The urgency is immediate, as Europe's virtual-world future fundamentally depends on motivated creative communities of interest/practice, across sectors/borders.
KA # 2 (ex # 7) *Professional-grade applications*	• Europe urgently needs professional-grade virtual worlds, moving beyond entertainment toward high-value applications such as digital twins, industrial XR, smart-city systems, human–machine collaboration and data spaces in EU areas of excellence. • This requires rigorous ROI-driven development, diverse sectoral testbeds, and flagship initiatives like CitiVerse and the Virtual Human Twin. Industry, designers, XR/VW associations, education actors, EU policymakers and financing bodies must jointly drive this shift. • Building such professional ecosystems is essential for Europe's technological sovereignty and for escaping dependence on US/Asian entertainment-led virtual-world models.
KA # 3 (ex # 5) *Key standards and interoperability*	• Europe urgently needs open, interoperable virtual-world standards covering avatars, assets, identity, data formats and measurable interoperability, despite strong proprietary pressures in the market. Progress will require policy and financial incentives, coordinated action from IEEE/ITU, XR/VW alliances, user communities, and EU instruments such as DEP, HE and EU ID/eWallet. • The need is pivotal and long-term, as interoperability underpins trust, identity, and scalable cross-platform virtual-world ecosystems. For Europe, privileging standards is a strategic stake to ensure sovereign, interoperable XR/virtual-world deployment.
KA # 4 (ex # 3) *Innovative partnerships (science-industry, PPP, cross-border)*	• Europe needs strong, cross-sector and cross-border partnerships to scale virtual-world innovation, moving beyond isolated creators toward community-driven and science–industry collaboration models. • Strengthened HE/DEP/EIT/ESIF pipelines, testbeds, DIHs and PPPs should accelerate translational pathways and motivate industry "pull". • New cooperation forms—PPPs, DAOs, open-innovation communities—must be incentivised to counterbalance the widening US venture-capital advantage. Because XR/VW lacks mature value chains, synergy-oriented support is an urgent policy priority for Europe's competitiveness.
KA # 5 (ex # 4) *Innovative financing schemes*	• Europe faces a structural funding gap, especially for SMEs and start-ups, due to limited venture capital and fragmented access to innovation finance. • Despite promising EU instruments (EIC, InvestEU, DEP, ESIF, DIHs), the ecosystem still lacks a coherent, navigable funding pipeline that helps innovators access, combine and scale these tools. • A strengthened continuum—from public programmes to private equity, angels and ESIU-type sovereign-innovation products—is essential to move beyond pilots and enable real scaling.

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	• The urgency is high, as delays deepen Europe's marginalisation and widen the gap between large firms and smaller innovators, particularly in XR/Virtual Worlds.
KA # 6 (ex # 1) *Individual and organisational skilling in the digital age*	• Europe faces a persistent talent shortage and brain drain in XR/Virtual Worlds, intensified by the rapid rise of AI and competition for digital skills. While Europe trains strong cohorts, the real challenge is retaining and financing innovators, and aligning skilling with funding, partnerships and real-world deployment. • The continent needs modular, continuous upskilling ecosystems—from technical experts to functional specialists in data, procurement, cybersecurity and ethics—driven by coordinated action from EU policymakers, industry, research and Member States. The urgency is high, as AI accelerates demand and the skills gap affects all digital domains, including XR/VW.
KA # 7 (ex # 2) *Societal stakes (trust, ethical, social & environmental issues)*	• Europe faces broad societal risks around virtual worlds—trust deficits, cybersecurity threats, misinformation, privacy concerns, digital divides, environmental impacts and mental-health vulnerabilities. • Existing EU regulatory guardrails (GDPR, DSA, DMA, CRA, etc.) help, but they must be strengthened and paired with international governance efforts to remain effective in a conflictual geopolitical context. • The challenge is to balance protection with enough freedom for innovation so creators and companies can still scale. • These issues are not unique to XR/VW, but they significantly affect the domain and cannot be ignored.
KA # 8 (ex # 6) *AI integration*	• AI has shifted from back-office optimisation (discriminative AI) to front-line creative enablement in virtual worlds, powering design, avatars, scenarios, events and community management. • Europe now needs both AI-literate creators capable of using GenAI productively, and robust safeguards against its risks—biases, fakes, cybersecurity flaws and untrustworthy content. • Regulatory guardrails (AI Act and predecessors) form a solid defensive base, but must be paired with capacity-building, open-innovation models and organisational upskilling so creators, public bodies and industry can fully harness AI. • The urgency is extreme, as GenAI evolves rapidly and new agentic, embodied AI, smart robotic systems, and brain-computer interfaces are emerging.
KA # 9 (new) *Geo-political stakes' watch and governance*	• Europe's virtual-world strategy cannot be separated from global geopolitical dynamics, which shape technological competition, economic power and the governance of digital ecosystems. • The EU needs continuous, anticipatory governance that balances protection (security, regulation, values) with promotion (innovation, competitiveness), supported by diplomacy, alliances and regulatory vigilance. • This requires coordinated action from EU institutions, Member States, NGOs, professional bodies and multilateral organisations. • The urgency is permanent, as geopolitical shifts demand constant watchfulness to preserve stability, values and strategic opportunities for XR/Virtual Worlds.
KA # 10 (ex # 8) *Sovereignty issues and phasing*	• Europe faces growing sovereignty risks as vast amounts of its data and digital infrastructure remain dependent on foreign actors across the entire tech stack—from cables and satellites to clouds, chips, AI and XR/Virtual Worlds. • Existing EU regulations (DMA, DSA, AI Act) help, but must be complemented by phased, long-term strategies that both protect and promote European alternatives, supported by dynamic value chains linking major players, SMEs and creators. • Addressing this dependence requires top-down EU and Member State leadership, informed by professional communities, and sustained over time—"a marathon with many sprints." • Ultimately, Europe should not try to catch up everywhere, but invest in niches of excellence where it can build high-value sovereign capabilities.

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5 POLICY RECOMMENDATIONS

5.1 FROM ACTION TARGETS TO POLICY OBJECTIVES

To close the life cycle of this roadmap build-up, we need to translate our five pillars and ten recommended actions into policy recommendations. In fact, each of the ten actions is, in its own terms, a form of recommendation. To make them more incisive, however, 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, for the sake of consistency), a process punctuated by policy recommendations that are essentially meant to be actionable and whose progress or achievements can be measured, in terms that will need to be specifically tailored.

A first level of recommendations is conveyed by the five pillars of our constructive work (see Chapter 3), covering Trust and Safety by Design; Interoperability and Data-Readiness; Skills, Financing Tools and SME Scale-up; Science–Industry Testbeds for Stronger Cohesion and Enhanced Sector Adoption; and Foresight-in-the-Loop. These pillars align with the original VW objectives published by the EU in July 2023.

The ten actions thus encompass, in their own terms, a series of implicit or explicit recommendations. Each deploys a narrative that basically says: "for this topic, here are the needs, and here is what should be done about them, on top of, or as a revamped form of, what already exists", with some indications of who should do it.

We have also stressed on various occasions that these actions should not be seen as silos but should produce their effects in synergy. For this reason, we propose not ten but six "bundling" policy recommendations, as follows.

We will see right after the coming policy recommendation chapter how to connect the Pillars, the Key Actions and the Policy recommendations, who should lead, with some considerations on the time horizon.

5.2 KEY POLICY RECOMMENDATIONS

1. **Concentrate on a) public-value niches with real pull and b) key areas of excellence**

   We have stressed and documented on various occasions during the OPENVERSE project, and again in this Deliverable, that Europe has strengths to build on, and probably needs to prioritise these qualities and avoid dispersing too much money, energy and talent. The domains mentioned above concretely involve needs, but also suggest opportunities that can demonstrate the added value of XR/VW solutions.

   The deployment table which will follow and show the interlinkage between this policy recommendation and the pillars and Key Actions, will concern (and therefore also who should lead): policy-makers, the scientific community, the various facets of industry in which the EU has attained an undisputable level of excellence, very concrete, measurable and operational:

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manufacturing, logistics, healthcare, security, the media and culture professionals, and also education in its various dimensions. Let's also stress, in case it is not already obvious, that the strength we focus on here is not something to build, but not to lose, therefore, in terms of timeline, **an immediate assignment.**

There are two complementary tracks to consider for this recommendation, pull (a mindset to develop and nurture across all innovative value chain[39]) and areas of excellence concentration:

- **In terms of partnerships** of diverse kinds and levels, including for skills (for skills, see KA 6) and trusted data spaces (this last concept should of course connect with the Common European Data Spaces promoted through Digital Europe -or DEP-, Horizon Europe, and EU4Health, supported by the Data Governance Act, Data Act, and the Data Spaces Support Centre – or DSSC-). The data spaces which are supported span across all the domains mentioned below

- **Addressing key target industrial sectors,** e.g. manufacturing, energy, logistics, healthcare, research, education & training, security & defence, concrete citiverse applications, culture heritage and tourism. Key motivating drivers are in particular the Flagships such as Citiverse, Virtual Human Twin, Industrial digital Twins.

2. **Promote partnership financing aimed at creating real added** value – medium-term ROI/scaling capacity, from an EU perspective but also in relation to the capillary network of national and cross-border initiatives[40].

   As the EU has not waited to engage in important support funding programmes, let's first stress that the main boosters that the EU is currently putting in place are essentially:

   - The next Multiannual Financial Framework (MFF)[41] and the new European Competitiveness Fund (ECF), i.e., new flagship fund proposed on 16 July 2025 as part of the next MFF, and designed to **streamline EU innovation financing**, replacing fragmented programmes with a single, InvestEU-style structure, and covering the full

[39] Let's emphasise that this may be counter-intuitive: researchers of the academic sector tend to pursue objectives of their own, quite understandably, then find something they value, sometimes envisage to "push" it to the market and engage in the start-up journey, eventually getting some seed funding, developing their innovation and ty to market it or make it buyable by a bigger player. This rather logical line of practice, on the influence of industry and policy-making should, to a large extent, be approached the other way around, i.e. determining what the needs of the market and society are, that industry can address, and then see how key partnerships can give a chance to this potential to eventually become a used product or service through an adequate development and testing process, an open innovation approach with a strong "pull" incentive. The two pathways may co-exist, but the "pull" approach should be strengthened.

[40] Here again lies the importance of the inventory initiated by OPENVERSE WP5 (also available on the OPENVERSE Observatory), which should be deepened and assessed and, if possible, lead to federating similar or complementary efforts among these existing, starting or planned initiatives, in an ambitious beyond-pilot mindset.

[41] The next MFF will embed a €234 billion European Competitiveness Fund (European Competitiveness Fund - European Commission), combined with €175 billion Horizon Europe, creating a €409 billion innovation and industrial competitiveness envelope.

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innovation journey: Research, Scaling-up / innovation, industrial deployment, manufacturing, infrastructure / deployment.

- EIC (The European Innovation Council)[42] + InvestEU[43]: the core innovation-to-investment pipeline, supporting not only deep tech and disruptive innovation, but also growth-stage guarantees to scale industrial deployment, which the ECF will absorb InvestEU's architecture, making this continuum permanent.
- the Scaleup Europe Fund, Scaleup Europe Fund: the new €5 billion late-stage deep-tech vehicle, under the EIC Fund umbrella and managed by EQT, anchored in public–private cooperation with major institutional investors (Allianz, APG/ABP, Novo Holdings, Wallenberg, Santander/Mouro Capital, etc.), and designed to close Europe's scale-up gap in strategic technologies, with first investments expected still in the autumn 2026.

We can see through the deployment of this arsenal, which have have discussed in our own workshops in 2025 and 2026, that the EU is currently deeply trying to handle the financing gap that has too often plagued its industrial innovation potential, especially in the targeted domains such as: AI, quantum, semiconductors, robotics, energy tech, space, biotech, medtech, advanced materials, agritech; and we we cannot but stress the coherence that is architectured that way, ending up with much larger and more predictable funding volumes, a unified access path, a true scale-up continuum, a geopolitical shift: innovation financing now tied to sovereignty, resilience, and strategic autonomy, and a new role for private capital, with institutional investors structurally integrated into EU innovation policy.

The question is will the different actors concerned by this paradigmatic shift follow, realising that there are alternate ways to US VC, and that it may also concern not only big players but also SMEs and partnerships between the two and PPPs. For us, there is in addition the question mark how the XR/VW domain will find its place in this new dimension, not as such (as a technology, which it is not), but as a combination of factors capable do delivering services and creating applications of high value in the overall perspective that the EU is putting in place. Given the fact private economy players are part of that collective effort, it will be important to follow, monitor, evaluate and improve if necessary, how the "market-pull" approach is supported, meant to emphasise real market or societal needs, motivating roles for smaller players too, ROI focus for all and longer term objectives.

3. **Boost sovereignty and independence** in XR/VW-related activities and applications through specific programmes and clear progression phases.

   Comment: The task is obviously enormous and must be approached in phases, with objectives and assessment, incentives, constraints, and deadlines. This concern clearly goes far beyond the capacities of XR/VW players alone, even at the policymaking level, and XR/VW initiatives need

[42] While the EIC focuses on deep tech, breakthrough innovation, early-stage and scale-up, it also promotes key instruments: EIC Pathfinder, Transition, Accelerator, and EIC Fund (equity) and seeks to enhance integration with other measures and programmes (e.g. Scale up fund).

[43] InvestEU is the EU's main investment-mobilisation engine, with a total of €397 billion mobilised by end-2025, providing EU guarantee to EIB Group and national promotional banks, equity, debt, and blended instruments, as well as an Advisory Hub and the InvestEU Portal.

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higher-level coordination, with concrete, specific objectives aligned with the broader strategy on the matter. If we can question how the XR/VW actors can feel associated to such sovereignty challenges as submarine cables, satellites, quantum computing or new chips (in fact, they are concerned, but it is not so easy to make this linkage concrete and effective, out of the overall autonomy-gain striving endeavour that the EU is engaged in), there is no doubt that the XT/VW domain is highly concerned by the existing gaps in terms of platforms, AI investment, data centres, smart robotics and also, before all, **an effective European cloud access**.

Let's stress that the EU is currently pursuing cloud sovereignty through a *new legislative act*, *strategic procurement*, and *massive infrastructure expansion*, involving:

- the Cloud and AI Development Act (2026),
- the Cloud Sovereignty Framework and sovereign cloud procurement, encompassing the SEAL evaluation toolbox – Sovereignty Effectiveness Assurance Level and a list of 48-criteria sovereignty score, grouped in 8 categories to ensure effective monitoring, progression and improvement as needed.
- the broader Technological Sovereignty Package (Chips Act 2.0, Open Source Strategy[44], energy-AI roadmap).

The goal is fundamental, it aims at: trippling Europe's data-centre capacity within 5–7 years, creating a **single EU-wide framework** to assess cloud and AI sovereignty, removing barriers to deploying sovereign cloud and AI infrastructure, while supporting **R&D and innovation** for next-generation cloud and AI technologies and accelerating cloud/AI adoption in **critical sectors** (health, energy, public administration).

For the XR/VW question, at least all the entertainment and socialization applications, the data flow is already an acute sovereignty issue, of which the makers and users involved in those practices may not be always aware of, which suggests that some form of supportive communication of even training and conditional access to funding should take place. For professional-grade applications, the problem is essentially the access to edge nodes that increasingly comply with above-mentioned sovereignty criteria.

4. **Focus on AI support to boost XR/VW for public-value innovation** and in key EU areas of excellence.

   The corresponding action is "AI integration" (KA8, but also KA6), which can take several forms (there are several types of Ai and different uptake options at stake). However, it is also a policy recommendation to embrace AI in its all its dimension and in particular its double-edged facets: all it can bring and facilitate, and all the problems that it also generates, and that have to be taken

[44] This particular component of the sovereignty struggle is very important for the XR/VR arena, too little developed until now, but within the new set of measures considered in this chapter, potentially more promising for the years to come, and in any case a critical factor of European autonomy. Along the journey to this Roadmap, we have seen that "open" man mean different complementary things: open source, open data, open innovation, as a minimum, but more globally, the capacity to redefine at European level, forms of legacy/ownership on digital assets that may keep the EU actors on the safe side regarding global dependencies. Going "open" is a must, for XR/VW and AI as well.

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care of in a proficiency-oriented but also eventually building a discerning-assessing and learning perspective.

The underpinning rationale is unescapable: today, and even more so tomorrow, with the development of GenAI and agentic AI, and with smart robotics and BCIs also entering the picture, XR/VW activities cannot be conceived outside these developments, while guardrails and discerning literacy must be deployed across users and organisations. This must be designed in relation to the emerging upskilling efforts that need support, with this double-edged consideration in mind: a constant governance challenge, including in the XR/VW domain as we have seen.

For this reason, use cases are important and associations which host makers and stakeholders of the different kinds active in this field. They should emphasise connections and values of such initiatives as:

- *Apply AI* refers to the EU's push to accelerate industrial and sectoral adoption of AI—especially generative AI—by SMEs, public authorities, and creators, not a single programme but a **policy strand** within the AI Innovation Package (2024) and the Digital Europe Programme; *Apply AI* is a **deployment layer**: it ensures that the upstream investments (EIC, InvestEU, AI Factories) actually translate into **real industrial use cases**[45], especially for SMEs and creators. Normally, it should resonate with the XR/VW makers and entrepreneurs.
- *AI Factories*, as **pan-European supercomputing-based hubs** providing compute, data, and talent to AI developers—especially startups and creators; one could thing this infrastructural effort to be beyond the scope of SMEs, but it is also intended to service developments needs of this category, often met in the European XR/VW arena[46].
- Precisely, aligned with this objective, *AI literacy for creators* is a very interesting policy focus as the human-capital layer, and clearly **in line with the support to AI-enabled creative ecosystems** (XR, virtual worlds, gaming) but which also clearly to do KA 6 on skilling.

5. Engage in negotiations and alliances to enhance the governance outreach of the EU digital ecosystem.

The rationale: Promoting initiatives and European-value literacy within the EU and the Member States must go hand in hand with governments and the EU negotiating what needs to be

[45] Apply AI covers sectoral deployment programmes (health, manufacturing, climate, finance, space), Testing & Experimentation facilities (TEFs) for real-world validation, Digital Innovation Hubs (EDIHs) offering hands-on AI adoption support, Common European Data Spaces (health, mobility, manufacturing, agriculture), and Funding for generative AI applications via Horizon Europe and Digital Europe.

[46] A close watch should take place to see how beside the 9 AI-optimised supercomputing spots and the planned AI Gigafactories, the AI factories and antennas already deployed as well as the new ones coming will be motivating and welcoming venues for SMES and start-up in the XR/VW domains. We just need to draw the attention of the necessity the see if the result matches the expectation and if not, to explore why and how to bring the necessary remedies.

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negotiated (a constant duty, in fact) on digital flaws, AI risks and problematic dependencies. This is for the governance side of the policy. The more operational side means pursuing already engaged collaborations or even deepening them, 1) with such international standardisation bodies as ISO/IEC and the anticipatory and advocacy-oriented normalisation activity of ITU (as well as European projects like StandICT, ViWisso, etc.); 2) in terms of cooperation, with Canada and also Asian countries such as Japan, South Korea and Singapore.

6. **Leverage our three scenarios and their ambidexterity claim to prepare for the next challenges** in an exacerbated global competition: e.g. brain–computer interfaces, smart robotics and the environmental pressure linked to GenAI.

   The rationale**:** In a fast-changing world (and both "fast" and "changing" really matter), maintaining an anticipatory mindset across policy deployment, addressing identified challenges while periodically reflecting on possible next-stage issues, is the inescapable hallmark of policies meant to be effective in an uncertain environment.

   A constant watch (or scan) of evolution not only of technologies that might play a role (see the OPENVERSE Technology Framework, which presents a full-fledged inventory), but also of the framework conditions, legal, commercial, geo-political that may affect the capacity to develop solutions or have access to funds or partners, as well as all the threats to the European values and their regulatory support measures.

   This watch may help spot and discuss trends, always necessary, but it should not be confused with real foresight consisting in designing and assessing, then confronting to the present, a series of possible futures, bright or dark, meant to enhance the collective capacity to cope with the complexity and uncertainty of futures, in XR/VW terms as well as for the needs they intend to address; in other words, what foresight-in-the-loop should periodically provide. Foresight can also be carried out concerning specific domains of activity (for instance XR in manufacturing or in city or healthcare twinning) as some sectors may have sudden levels of uncertainty to face, making anticipatory moves stimulating deep dives and a collective learning experience.

5.3 CONNECTING THE REAL DOTS FOR 2027 AND BEYOND

The challenge, at this level, is to connect the dots, between the Pillars, the Key Actions and the Policy Recommendations, with in addition some indications on who should lead and for time horizon and other precautions to keep acute. Ideally, as said already, all these bricks of the future we want to make possible and effective are somehow interlinked, leading to a matrix-type of diagram, but difficult to read. We need to approach this interlinkage and their main factors step by step.

Let's start with an overview, which help us keep in mind the essential building blocks and their underpinning dimensions:

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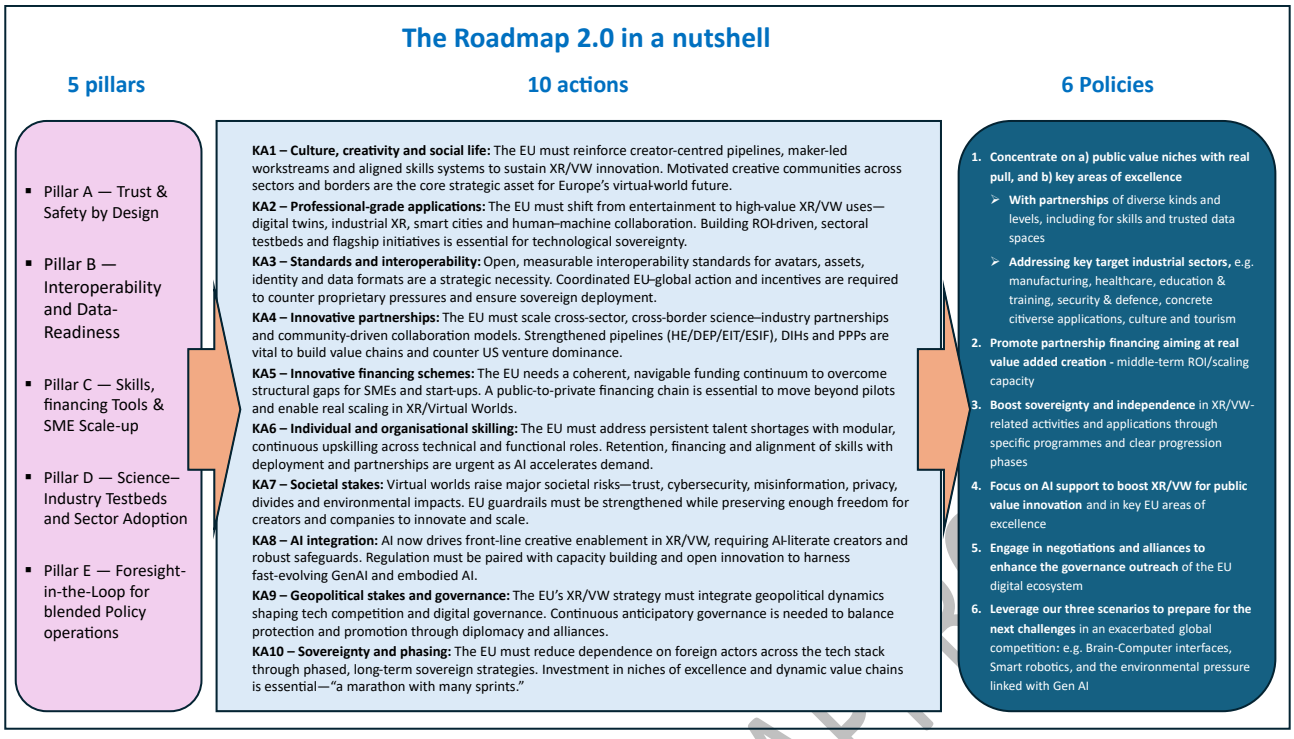


Figure 12: The Roadmap 2.0 in a nutshell

As a in a document like this Deliverable, as we conceived it primarily to guide decision-makers, it is nearly impossible to map all connections that may link these three types of expressions of the roadmapping perspective. However, let's emphasize some strong value flow and capabilities to be put in place, starting backcasting-wise, with the policy recommendations, this time only mentioned by their title:

Table 5: How concretely Pillars, Key Actions and Policy Recommendations should combine

Policy recommendations	Pillars and Key actions	Deployment indications
1. **Concentrate on a) public value niches with real pull, and b) key areas of excellence**	Main Pillar(s) concerned: **Pillar D**: Science-industry testbeds, and sectoral adoptions, but also, Pillars **C** (skills…) and **E**: foresight… Main KA lever(s) to consider: • **KA 4**: Innovative partnerships, but also, **KA 2**: Professional grade applications, as well as: • **KA 10**: Sovereignty issues and **KA 8**: AI integration (which should avoid being only a catch-up game and privilege key synergetic targets)	The **pull approach** (detailed in Chapter 5.2), is especially important in the science-industry interactions and partnerships. Excellence is one of decisive factors for sovereignty clause prioritization ("people need us more than we need them") and it is also relevant for KA8 (AI integration) and, of course, for KA2 (Professional-grade deployment) For: XR/VW in the industry (manufacturing, energy, logistics, healthcare, security-defense), but also in the creative and media economy, in smart cities, tourism, and even the environment. The three EU Flagship programmes mentioned earlier are of course premium drivers of that perspective. The timeline could be worded: "continue doing what is being done".

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1.1 **With partnerships** of diverse kinds and levels, including for skills and trusted data spaces	The above-mentioned linkages keep being relevant, but with emphasis **on Pillar C** (skills and financing tools for SMEs and start-ups), meaning to purposely focus on certain objectives and areas rather than dispersing resources, and obviously, too, with main focus on **KA 4** (innovative partnerships) as well as **KA 6** (skilling) and **8** (AI integration).	Things may change, **Pillar E** should not be neglected (foresight); assumptions, resource allocations and objectives to be periodically revised as needed, especially regarding how KA 10 (Sovereignty= evolves Professional and higher education stakeholders as well as innovation financing support player should be added to the list of who should lead. The timeline? It starts "now".
1.2 **Addressing key target industrial** sectors**,** e.g. manufacturing, energy, healthcare, education & training, security & defence, concrete citiverse applications, culture and tourism	Main pillar(s): **Pillar B** (standardisation and interoperability and data readiness), but also as indispensable complements, **Pillar C** (skills& financing for SMEs), as we shall see with KA4 Main KA: **KA 2** (professional-grade deployment) to more clearly tune XR/VW to economic development needs, but ineluctably too, **KA 3** on standards and interoperability to accelerate partnerships and reuse of success processes and cooperation configurations.	The previous chapter (5.2) as well as on several occasions in this Deliverable, the list of 10-12 key sectors of target with XR/VW deployments keeps being relevant. In a slightly different timeline, as environmental issues grow in intensity and dramaticity, agriculture, food and healthy living and climate literacy and mitigation initiatives may also emerge in the foreground. Finally, as a referee, KA 10 (Sovereignty) should never be forgotten when it comes to assessing and ranking engagement endeavours, but of course, with that factor, different timelines may be envisaged (phasing).
2. **Promote partnership financing aiming at real value added creation -** middle-term ROI/scaling capacity	Main Pillar concerned: **Pillar D** (science industry partnering) and **C** (opened to new financing schemes). However, some level of trust is also necessary to engage in partnerships (Pillar A) and openness to interoperability schemse an evident option (Pillar B) Main Key actions involved: **KA 4** (innovation partnerships) and **KA 5** (Innovative financing schemes). However, for connecting reasons, **KA 2 and KA 3** are also concerned.	As seen in the actions' description as well as in the policy recommendations' presentation (chapter 5.2), this policy is quite complex to apprehend and deploy. If we analyse the new funding support concept that the EU has deployed (which we have done, see chapter 5.2), we find out that, indeed, the problem was embraced at that level, meaning to address not one or two, but all the main factors at stake, conjunctly and in synergy. Who should lead? EU policy-makers, industry, research, health, cities, Member States, financing providers and XR/VW associations, along with the European programmes already mentioned (see chapter 5.2) The timeline: Starting now will take 5-8 years to achieve full deployment, probably less, administratively speaking, but probably more in terms of what ti will take to change mindsets and habits.
3. **Boost sovereignty and independence** in XR/VW-related activities and applications through specific programmes and clear progression phases	**Pillars B and C** are mainly concerned. Key actions **KA 2** (professional - grade applications), **KA 3** (standards and interoperability), and, of course, **KA 9** (geo-political stake	The key problem is not to engage in particular fights, especially in a domain like XR/VW, quite co-dependent upon many other technologies, but to coordinate and require an assessment in most activities and choices whenever possible. In OPENVERSE, we have seen how difficult (especially in the gaming

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	and governance) and **KA 10** (sovereignty phasing) are all co-necessary.	and socialising VWs) it was to disenfranchise from US dominance and how phasing this much needed process may be important. However, in some domains, like professional-grade applications, we are rather on the safe stand. In general terms, the Cloud autonomy efforts engaged by the EU is the way to go. Who should lead on this policy recommendation? Top-down engagement is indispensable, from the EU and then the Member States, but also from professional associations and communities of makers who can act as listening posts, relaying the on-the-ground realities decision-makers' needs. It will take 5-8 years before the balance shifts to the right side, but it is indispensable and the sooner the better.
4. **Focus on AI support to boost XR/VW for public value innovation** and in key EU areas of excellence	Main Pillars concerned: **Pillar A**, for the capacity to balance the good and bad sides of AI, **C**, for upskilling needs, and also, even as minor contributions: **D** (European science at work) and **E** (foresight) Key actions to consider: **KA 8** (AI integration) of course, but also considering what it takes to "integrate" AI in actual and efficient activities (**KA 2, KA 4**) and also, in a more defensive approach, **KA 7 and KA 10**. **KA 1** on media and culture may also play an important federating role.	Given the importance that Ai has taken in the XR/VW domain, and the need to keep on striving and, at the same time, to learn how to cope with the possible flaws of AI and not only as an individual capacity but also at organisational and public sector level, **AI being transformative for most activities**, the purpose is not to isolate Ai as a specific action, but on the contrary, to see how it fertilises or, on the contrary, pollutes the diverse activities it can support and create thereupon collective investment and learning effort. In terms of who should lead, let'0s observe that when it comes to regulating, the policy is already in place, however, the stake is to maintain the ambidexterity: being both, but in a balanced way, defensive and proactively innovative. As it changes fast, the policy is to be enacted, on top of the existing arsenal for the promotional/sectors side, **immediately**, but knowing that **it will be necessary to revisit the state of affairs and the to-do list quite often**.
5. **Engage in negotiations and alliances to enhance the governance outreach** of the EU digital ecosystem	Pillars that matter most are **Pillar A**, to preserve what needs to be, **Pillar B**, to construct channels of cooperation, and **Pillar E**, to periodically revisit the challenges and threats that we may be confronted with. Key actions we need to emphasize are, of course, **KA 3** (standardisation and interoperability), **KA 4** (innovative partnerships), in	This is a difficult policy assignment, as it means concretely engaging in regulatory advances and negotiations in different directions: EU-wise and in member states for the cohesion and adhesion of non-state actors, including the regional-local level, but also internationally speaking, to construct the framework conditions of advances in values and compliance with countries often having a different view and interest. Who should lead? The EU and the Member States, but also NGOs, professional

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	particular with the countries evoked earlier (Canada, but also Japan, South Korea, Singapore) and **KA 9** (governance negotiations) and **KA10** (sovereignty endeavours) Same as in the previous recommendation, let's stress that **KA1** on media and culture can also play an important bridging and federating role.	associations and private organisations linked in one way or another to our topic, the scientific community and, if they are still able to mobilise and act, specialised multilateral organisations. The timeline: the efforts already engaged should continue, the diversification of alliances being an essential move, even if it takes time (there cooperation-ready countries and others we need to learn how to do it with)
6. **Leverage our three scenarios to prepare for the next challenges** in an exacerbated global competition**:** e.g. Brain-Computer interfaces, Smart robotics, and the environmental pressure linked with Gen AI	We can discuss on other pillars' relevance, but the main one here is **Pillar E** (foresight in the loop for policy blended operations). Yet, as things change rapidly, **Pillar A** will be essential to keep a cape. Key actions to privilege: **KA 1** (Culture, creativity and media), **KA 2** (professional-grade applications, and to a lesser extent; KA 3, 4 and 7, but of course one important Key Action, is **KA 7** on societal stakes: XR and VW deployments are not just a technological problem, far from that.	We have dedicated our own foresight exercise to the existing situation, but soon (or even already) new entrants will shake our certainties again and force us to revisit our XR/VW agenda: smart robotics, agentic AI, quantum computing, Brain-computer interfaces, and they will raise new safety issues, new societal challenges, new gaps in the sovereignty struggle and therefore new skills and governance negotiations. This is a duty for the EU and MS policy-makers, as well as their executive governmental agents, but more we should not forget the scientific community, who, more than the corporate players, may be inclined to consider the longer term. As said before, beyond the trend monitoring envisaged as a permanent activity, foresight should be a periodic or specialised one.

At this point, we have the details and explanations, but we need to have a more workable action plan, which can be a starting reference to conceive and then deepen possible collaborative endeavours, synergies, innovative initiatives and measurement options with any interested partner or relevant policy-making representative, of how the targeted goals can become closer and attainable, i.e., a synthetical presentation, yet capable of encompassing the rich substance described in this Deliverable, which is outlined for that particular purpose in the following figure:

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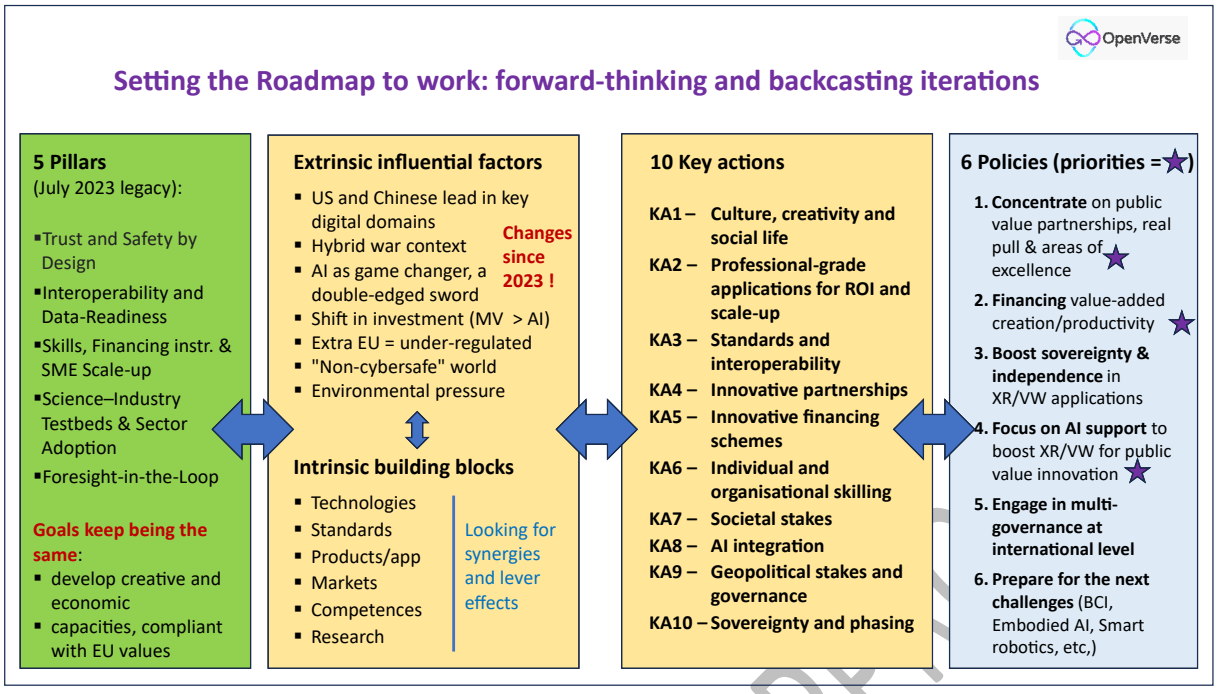


Fig. 13. Configuring the OPENVERSE Roadmap for collaborations and synergies

In this diagram, we can see that the intermediate steps between 1) the pillars, which represent the legacy of the EU goals as expressed in July 2023, with the ambidextrous perspective we advocate and 2) the recommended policies, with already an early indication of which ones should considered as absolute priorities, as they can be considered levers for the other ones:

- The different types of factors, either internal to the XR/VW progression (and within which of course, the technological ones) , or external and likely to weigh on the effectiveness of the actions engaged and that, at least, should be watched and taken into account.
- The 10 key actions as initiative and motion-setting capacities, with all the synergies that can be triggered and supported among the different actions.

5.4 THE PRIORITISATION CHALLENGE AND THE ASSOCIATED TIMELINES

While all actions proposed and policy recommendation outlined are clearly important, there is a need to prioritise strategic interventions in order to ensure the roadmapping is effective and generate high impact, addressing concrete challenges and solving real-world problems, also in light of the resources available and that can be deployed.

We therefore propose two lines of reflection on prioritisation. One is to assume that the five pillars are in any case a reference framework for arbitrating or ranking different options as they represent a bottom line reflecting at large the legacy from the EU July 23 strategic declaration for virtual worlds and the Web4.0. The other one is to consider that the sequence proposed here is, *de facto*, a guideline for prioritising these policies and the actions they may mobilise. We can do it and will do it (see further).

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However, we also want to stress the underpinning process involved, as it may help in further circumstances in which other external factors would have changed the suitable order of things.

The first point we want to emphasize is the fact there is no **"one-size-fits-all" priority recommendation that would be valid for all** (the EU, the Member States, and others) and likely to remain so for a long period of time. Instead, the world is changing and multiple. Members States in particular, may consider necessary customising the policies we recommend). Besides, things change very fast, especially in a conflictual context as today and with the influence of AI across the board a fast-track game-changer, apparently. We therefore must conceive objectives, ways of attaining them and keep in mind to stay agile and capable of adaptation if absolutely needed. This means that **our policy recommendations are for the EU level policy-makers**, and if considering any other public, it might become problematic

Precisely, in order to provide pointers to future policymakers, mainly at EU level, in the general conduct of XR/VW or related digital policies, in specific domains that would make good use of XR/VW solutions, but also, with possible adaptations, in Member State contexts, we have formalised a possible prioritisation process as follows:

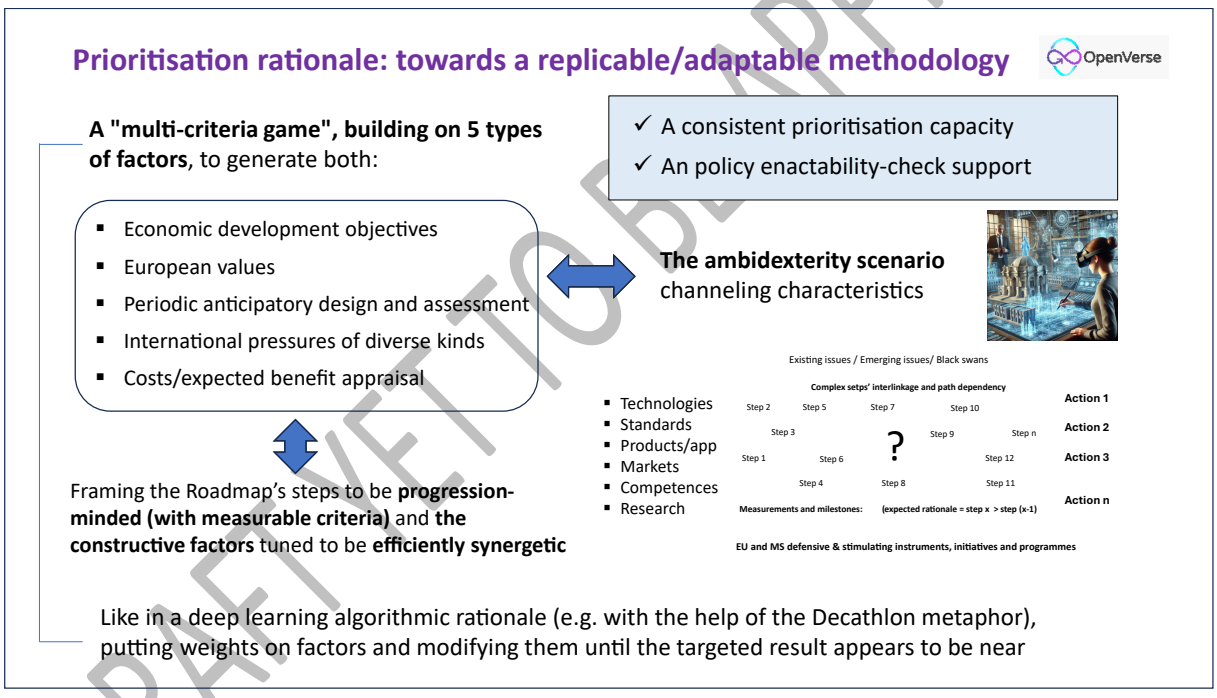


Figure 14: The prioritisation rationale: towards a replicable/adaptable methodology

Now, having expressed all these methodological considerations, we can unleash our own assessment.

Quite clearly there are three policies which are, if not absolute priorities disqualifying the same claim from the other ones, at least conveying a level of urgency and a timeline which make them actual priorities and beyond this "readiness" context, a characteristic which qualify them for prioritisation: they can be considered as levers of action for the other policies. These priorities are as follows:

- **Policy # 1: Concentrate on: a) public-value niches with real pull and b) key areas of excellence,** in terms of partnerships and addressing key target industrial sectors.

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- **Policy # 2: Promote partnership financing aimed at creating real added value –** with medium-term ROI/scaling capacity, from an EU perspective but also in relation to the capillary network of national and cross-border initiatives

- **Policy # 3: Focus on AI support to boost XR/VW for public-value innovation** and in key EU areas of excellence

This three-some prioritisation does not mean that the 3 other policies are not important, but that they hold a different timeline or application regime, either a longer-term effort to obtain results (sovereignty), or representing somehow a never-ending job (like engaging in governance negotiations with others to promote similar regulatory acceptance, or in a foresight activity, either a trend watch or a periodic exercise).

In case of doubts, the pillars should arbitrate, as they represent, as already said to a great extent, but it is still worth insisting, the legacy of the original strategic objective on virtual worlds, formulated by the EU in July 2023. In fact, if one considers the three priorities above, one can observe that they are proactively oriented towards economic development. **This is where the Pillars are so important, as they encompass the already existing capacity to preserve values and ensure the level of defensive means and guardrails against the innovation-minded choices which we advocate.**

In other words, whatever the priority, the promotion we did of an ambidextrous mindset, means to be capable of creating, launching and supporting innovative initiatives (it is a priority we suggest to deploy), but at the same this has to be kept rooted in values and defensive tools (as the world is not ideal), something which we already do and must continue to nurture.

Eventually, as it was recalled at the OPENVERSE Summit on 10 September 2026 when the proposed roadmap and policy recommendations were presented, the roadmap is not a perfect algorithm to solve everything, once and for all, but it constitutes a set of practical guidelines meant to help people advance and solve real problems, i.e. policy-makers, but then, also all the targeted stakeholders. Solving problems, in this double entry perspective, means to keep being capable of adopting a precautionary and protective attitude regarding the risks involved in our current context, linked to digital technologies or not, while not inhibiting makers and entrepreneurs of the XR/VW arena to contribute, at their level, to a large scale “Draghi effect”.

We need here to stress the importance of the first two policy recommendations as if XR/CW developments do not address real problems with a convincing ROI and scale up perspective, we keep confined in the era of pilots that never produce any fruits. In that context, the brand new funding scheme developed by the EU, through an arsenal of converging and synergetic instruments supported by a consistent mindset, as already explained, will have to prove its efficiency to bring makers, creators, communities of interests and companies of all sizes to the motivating expectation that this new funding horizon will allow them to compare their chances with what they could obtain from US or Asian investors. In addition to the funding aspect, if it works as expected, it will also help retain or even attract the skilled manpower in the EU. Finally, AI, will make a difference, both in the support to

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creation and virtual asset exploitation, but also to partnering, conceiving consistent business plans and engaging in the commercial stage with the right credentials, beyond the sole technological focus, as it is too often the case.

Having said that, the remaining question, beyond the prioritisation issue as a specific problem, is that of the timeline for the 10 actions and the 6 policies, to be nurtured upstream by the factorial support and the hurdles to be coped with for a convincing timely deployment. However, after having tried, as always, to associate to each action or policy a specific timeline, we came to formulate a more realistic timelining perspective.



Fig. 15. The multiple factors involved in the tuning of the Roadmap' priorities with timelines

How to connect all these dimensions in a coherent manner?

We can think in terms of **time horizons** and for some issues it may fit (e.g. quantum computing), but also of **time relationships, in fact a multi-faceted time landscape,** in which we can distinguish:

- **Sprints**, meaning "starting now and being fast" (e.g., in particular, **the three priority policies**, but also, the struggle for more sovereign **cloud services and AI capacities**)
- **Marathons** (interoperability standard build up, sovereignty issues)
- **Every-day exercises** (e.g., open source promotion, cybersecurity fight, creative initiatives)
- **Crosscutting themes** (e.g. BCIs, AI & XR/VW for emotions, children protection, EU values, skilling issues, governance)
- **Increasing problems/gradual tech evolutions** that at some point of time (when is the question) will have to be taken care of (e.g. environment pressure, quantum computing)
- **Wake up calls**, to be repeated if needed and with **gap** to evaluate (e.g., Smart robotics)

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The key stakes, at this stage, are:

1. How to translate these concerns/patterns in real-time horizons and phases that are both credible and reasonably actionable (for the Roadmap 1.0, we made proposals, but in reality, it remained an open discussion)?
2. How to also take care of conditions, possible inhibiting factors, but also synergies, and uncertainties?

There is no perfect way to assign timelines, but the following rationale offers a structure that is consistent with all previous suggestions while providing indicative timeframes useful for policy implementation. Given the complexity of the fast-changing situation we face, this design should be seen as a reasonable attempt to serve the original purpose: clarifying what we aim to achieve with virtual worlds, why they matter, how we can realistically reach those objectives, and which conditions must be addressed to turn this ambition into a practical contribution to real problems and needs.

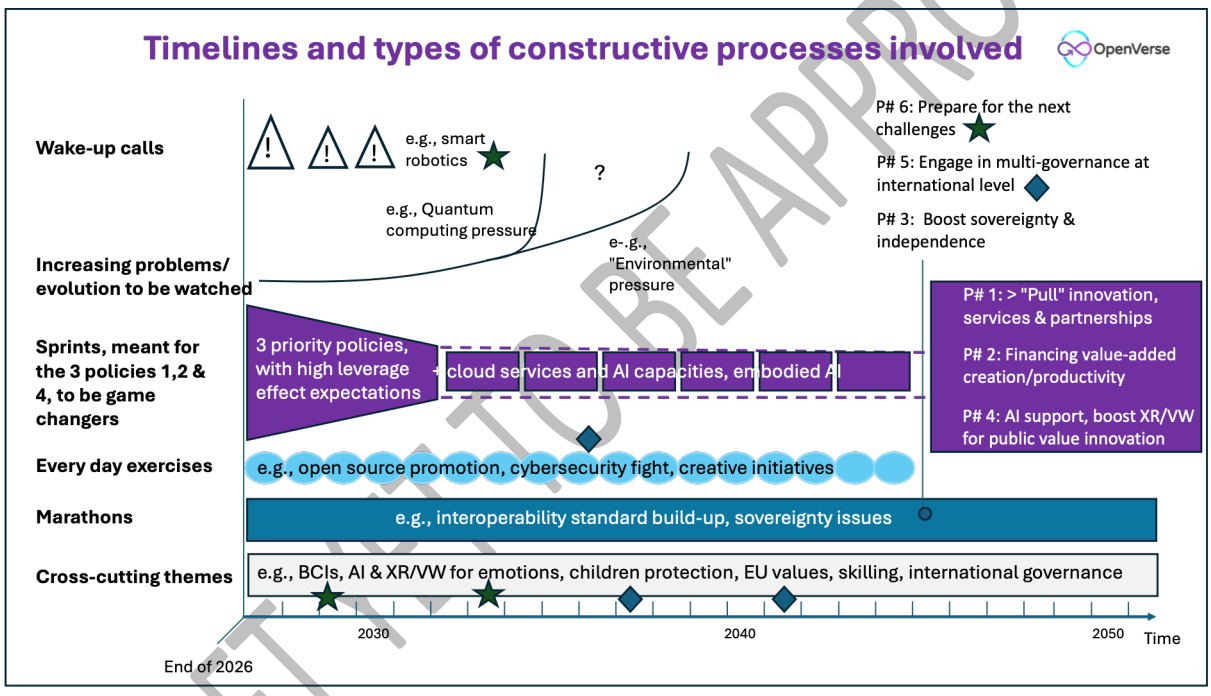


Fig. 16. Timelines and types of constructive processes involved

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6 FUTURES

6.1 MAKING THE ROADMAP AN ACCESSIBLE DOCUMENT

As this Deliverable shows, there are several possible presentation formats for the Roadmap. Depending on the needs (further research and debate, or immediate policy discussion for near-term deployment), the reference document can be more or less substantial, and its graphical form can also be developed specifically and can also be further elaborated into interactive digital formats.

In this respect, the Roadmap was conceived since inception to be embedded after the project's end in the OPENVERSE Observatory, where it already sits. Now, near the end of the project, and taking into account several requirements that arose along the way and proved relevant in today's changing context, several possible tracks for valorising the OPENVERSE Roadmap appear.

The Roadmap is now embedded into the OPENVESE Observatory, available as a virtual asset at this link https://observatory.open-verse.eu/virtual-worlds-roadmap

6.2 MAKING THE ROADMAP A LIVING DOCUMENT

As the funding ends with the action, there is the obvious question, quite normal at the end of a European project, of whether the Observatory which embeds the Roadmap, will continue to exist and develop, and thus be able to keep hosting the Roadmap. In this respect, a collaboration agreement between the developers of the Observatory (OpenVerse Observatory | Mapping the Future of Virtual Worlds), Trust-IT and the XR4Europe Consortium partner has been envisaged[47], giving a virtual home for the continuation of the Roadmap as a interactive living document.

However, the main line of action suggested and agreed with the relevant Commission Services, is to engage in discussions with key players in the field, and in particular the Virtual Worlds Association (VWA), with a view not only to hosting the Roadmap but to evolving it according to future challenges and needs, in order to ensure the relevant stakeholders can benefit of the Roadmap. The ultimate goal is **to make of the Roadmap a living document** that can continue playing an advisory and anticipatory role for stakeholders who can use this potential and be guided through the process to design and implement actions which can have a high impact on the European VW and Web4.0 ecosystem.

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[47] As of end of October 2026, it is not yet completely clear whether XR4Europe plans to manage the Roadmap in its platform. It will certainly remain in the original OPENVERSE platform, although any updating process after the end of OPENVERSE is still unclear (i.e. an open discussion). Agreed that the best route of all would be curation through the VWA, but the XR4Europe plan remains a strong option..

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7 CONCLUSION

7.1 A STOCK OF CONVERGING GOALS: SOME EXTRA OPTIONS TO CONSIDER

The target areas the OPENVERSE Roadmap is designed for have been mentioned several time. However, to make sure they are aligned with the EU strategic legacy and how the VWA is now taking up this strategic assignment, let's say that the Roadmap is a *minima* aligned with the 8 priority targets that the VWA advocates, as follows

- **Industry & Manufacturing**
  Digital twins, simulation, design, production optimisation, maintenance, and industrial collaboration.
- **Healthcare & Well-being**
  Medical training, diagnostics, therapy, rehabilitation, telemedicine, and patient-centred care.
- **Education & Training**
  Immersive learning environments, professional training, reskilling, and lifelong learning.
- **Media, Culture & Creative Industries**
  Entertainment, cultural heritage, museums, creative content production, and immersive experiences.
- **Security, Defence & Resilience**
  Crisis management, emergency response, training, preparedness, and security-related applications.
- **Cities & Public Services**
  Smart cities, urban digital twins, citizen participation, planning, and public administration services.
- **Socio-economic, Legal & Governance Frameworks**
  Ethics, trust, human rights, regulation, sustainability, societal impacts, and governance models.
- **Infrastructure, Interoperability & European Sovereignty**
  Cloud-edge infrastructure, data spaces, networking, standards, interoperability, semiconductors, and strategic autonomy.

To this list, we could perhaps, as we have worked on these topics quite extensively, add four stimulating target domains for Virtual worlds:

- the **Environment**, which can of course be envisaged as embedded in come of these topics, like cities or public services, but we believe that the environment deserves an attention of its own, with use cases, Proof of concept use cases, measurement of ROI and performance enhancement if it is for the public sector, etc.
- **Tourism**, and again, it can be understood as embedded in some of the above-mentioned topics, but it is a domain where there is already quite a lot of XR/VW achievements;

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- **Agriculture**, which can of course be considered as an industry, but which involves characteristics of its own, especially for the spatial monitoring of its activities;
- **Sport**, as it functions already as a lab for XR/VW explorations and functional applications, as well as a ROI rationale of its own.

Worth stressing is the fact that some generic and cross-capacities may not be target areas of the same kind as the ones mentioned until now, but will play an increasing role and this should be stressed:

- already, massively, the different AIs (discriminative, generative, agentic and embodied);
- already, but still convincing for the moment only for functional restorations in the healthcare sector, but already explored and discussed in other sectors, i.e., the Brain-Computer interfaces;
- part of the manufacturing and automation rationale, but not only (it may be considered for healthcare and defence, as well): smart robotics.

These developments are increasingly important and intertwined with XR-VW developments, boosting them, opening new avenues, for which our Roadmap's methodology should be envisaged if the goal is for the XR/VW domain to accommodate these incoming capacities for the different target areas it has already considered.

7.2 BACK TO THE FUTURE: THE NEXT STAGE'S OBJECTIVE

We have outlined several important technological evolutions which can prove relevant for the XR/VW domain. However, and this is in line with the 3 priorities for policy recommendations (section 5.4), if one is to imagine how research (or applied research) can continue with the objective of improving the Roadmap relevance in the coming years, for the EU and its preferred specialised consortia (such as the VWA), then the main issues, building upon the insights and references from our previous work (D2.4 and D2.5), are mainly:

- **How to measure ROI in the way private and public sector players can implement, develop and exploit XR/VW solutions?**
- **Which are the conditions to consider and nurture for effective scale up evolutions?**
- **How to replicate things that work or, upon existing PoCs, inspire new players with a growing stock of efficient solutions, for real problems to be tackled but also real value added?**
- **How to combine solutions and skills for new approaches, usages and business models?**

The Roadmap, as it is, with its interdisciplinary perspective and its methodological grounding, is ready to integrate this new stage of requirements.

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