



Industrial Metaverse

Chancen für die Photonic und Quantentechnologien?

PHOTONICS GERMANY Zukunftsgipfel und Branchentreffen 2024
Berlin, 11. Juni 2024

Prof. Dr.-Ing. Dipl.-Kfm. Christoph Runde

Managing Director of Virtual Dimension Center w. V.

Project Lead „Living Lab XR-Interakt“

Founder of XR EXPO

Vice President „Industry & End Users“ of European Association for Extended Reality (EuroXR)

Chairman of Standardization Committee „eXtended Reality und Metaverse“ at DIN e.V.

Honorary Professorship Heilbronn University

VIRTUAL DIMENSION CENTER



Living Lab
XR-Interakt



Let's assume they're all talking about more or less the same....



Metaverse



Omniverse



Spatial Computing



Virtual Worlds



The Metaverse Coordinate System

distributed-collaborative V/AR;
decentral data storage;
Web3.0 / blockchain

**collective
spaces**



hardware competency

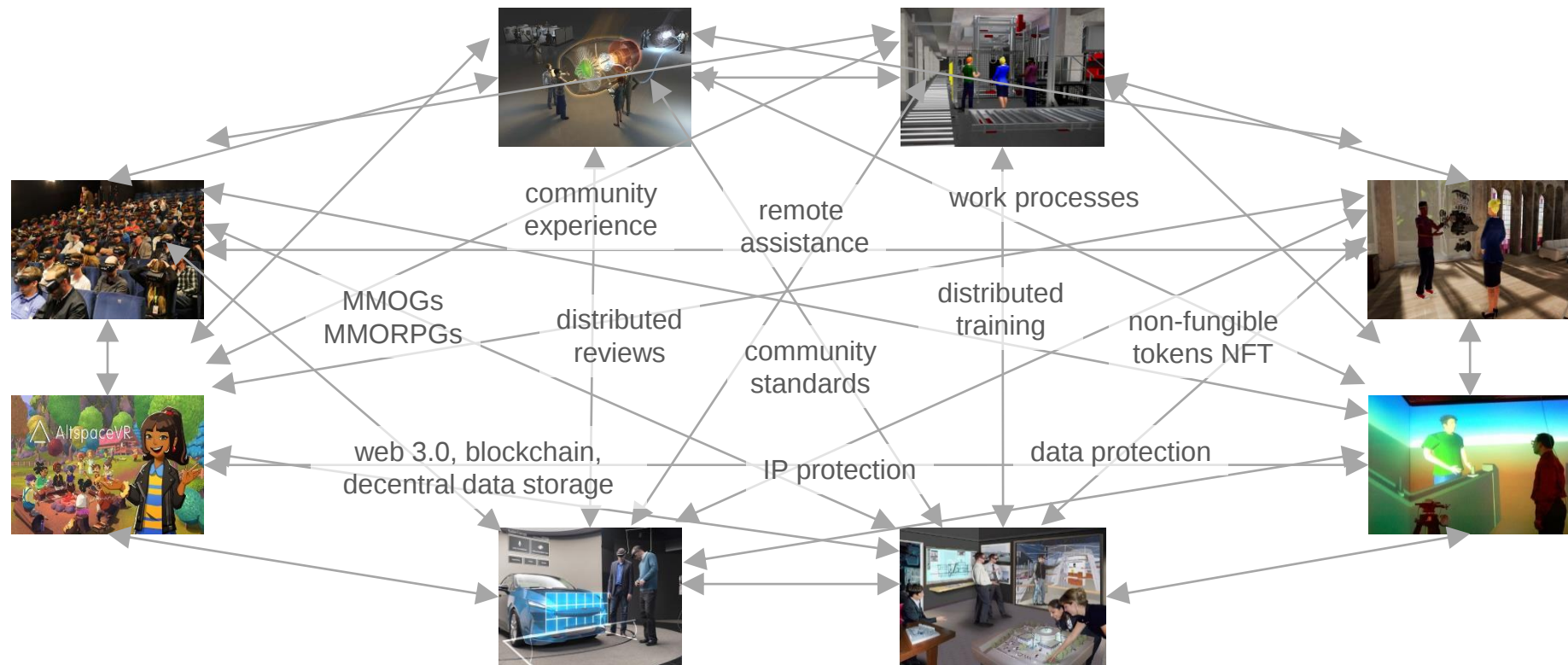
**seamless
interaction spaces**

digital twin

competences on capture,
planning, design, assistance

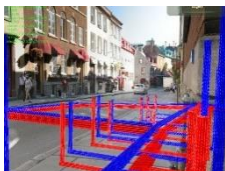
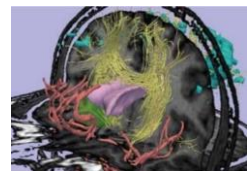


Collaborative XR environments, with rules, ethics, ownership, safety and security





Cyberspace is a mouldable, persistent image of reality, and vice versa.



health & care



construction



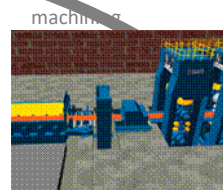
logistics

Cyberspace is an image of reality and makes it possible to accompany, improve, control and master it.

vertical
integration

Virtual Reality (VR)

reality



machining



fashion

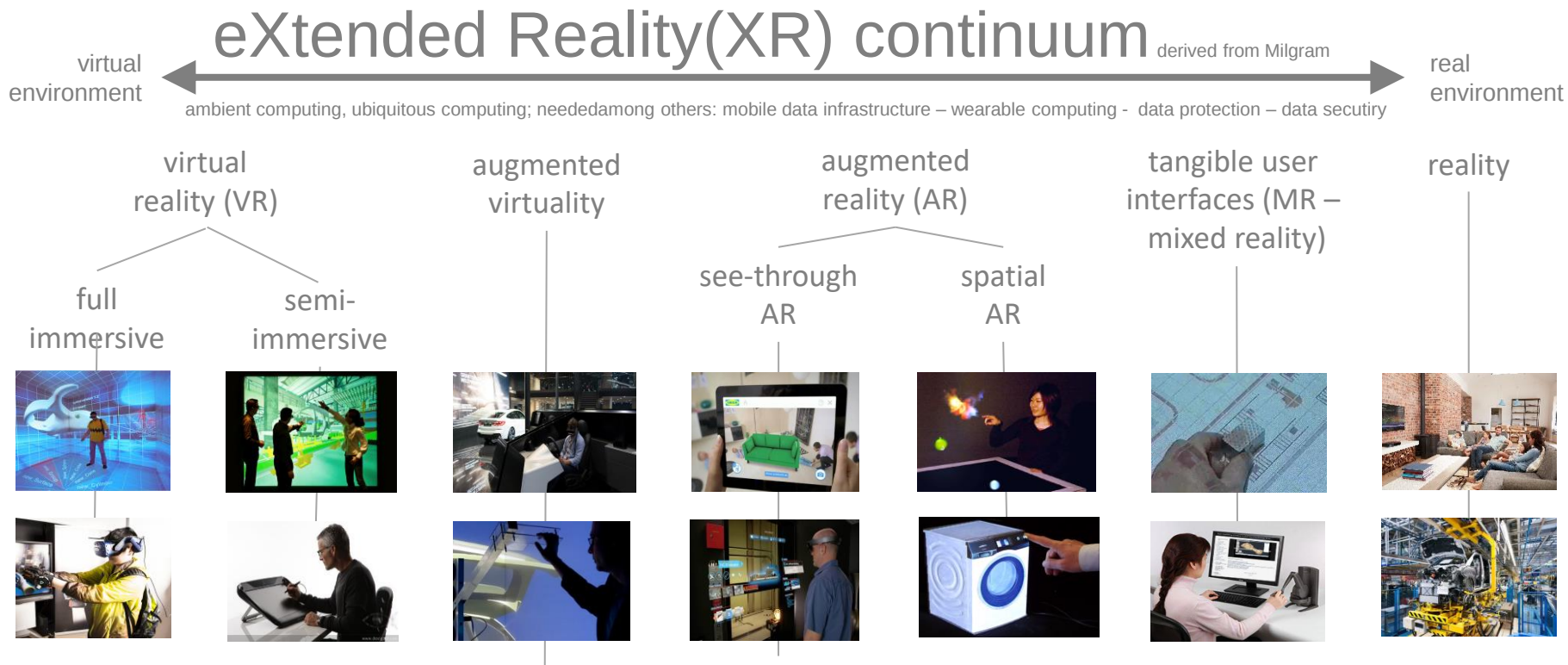


services

Reality is planned, tested and experienced with the help of cyberspace.



Hard boundaries between fully synthetic virtual reality and reality will disappear.



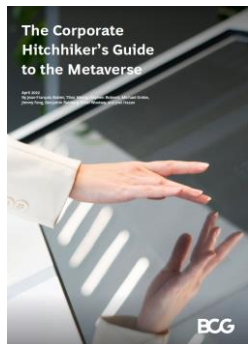


Example BMW & Nvidia Omiverse

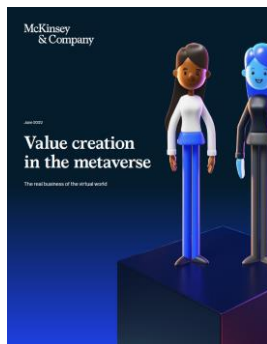




studies and analyses on industrial metaverse



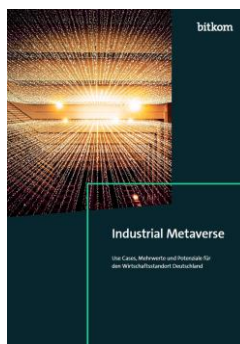
2022-04 –
The Corporate
Hitchhikers Guide to
the Metaverse –
Boston Consulting
Group BCG



2022-06 –
Value Creation in the
Metaverse –
McKinsey



2023-03 –
The Emergent Industrial
Metaverse – Siemens
und MIT



2023-06 –
Leitfaden Industrial
Metaverse – bitkom



2023-06 –
The Metaverse at Work
– Nokia und EY



2023-10 –
Exploring the Industrial
Metaverse: A Roadmap
to the Future – World
Economic Forum und
University of
Cambridge

benefit & use cases metaverse



Metaverse Use Cases in the Automotive Industry

	Product/Process engineering	Manufacturing and supply chain	Sales and marketing	After-sales
AR/VR/MR	- Digital-first design (product and assembly) - Augmented milestone reviews - Engineer training	- AR-augmented manufacturing - Operator training	- Virtual showroom - Virtual test drive - VR-supported sales conversations - Immersive ads/brand media	- Virtual simulation of upgrades and accessories - Virtual repair guides - VR-supported driver training
M-worlds/ virtual economy			- Immersive brand presence in virtual worlds - Virtual-asset transactions in m-worlds	- Brand fan community NFTs - M-influencers

Value creation in the metaverse

The real business of the virtual world

What's the opportunity?

In 2021, venture capital and private-equity funding into the metaverse reached

\$13 billion

By 2030, the value of the metaverse could reach...

~\$5 trillion

In 2022 already, investment into the metaverse space is more than double what it was in all of 2021

>\$120 billion +

Consumers and brands are already engaging

59% of consumers are excited about transitioning their everyday activities to the metaverse

57% of metaverse-aware companies say they are adopters

Top 5 activities consumers are excited about

Social
Entertainment
Gaming
Travel
Shopping



Top 5 enterprise use cases companies are implementing

Marketing campaign or initiatives
Learning and development for employees
Meetings in the metaverse
Events or conferences
Product design or digital twinning

benefit & use cases metaverse



The industrial metaverse will significantly transform many highly competitive markets. By enabling and connecting real machines, factories, offices, and other complex systems in the digital world, it will improve collaboration, from customer to health care, to solve extraordinarily complex real-world problems digitally.

This new phase of digitalization will enable virtual worlds that predict equipment failure, autonomous trucks that optimize logistics, collaborative robots that boost productivity, and sophisticated supply chain optimizations. Its reach will extend far beyond the development of products and the maintenance of machines to facilitating collaboration of specialists from anywhere and creating new insights for product design and manufacturing. "You can find use cases anywhere in the industrial life cycle and make it better with industrial metaverse," says Ian Fisher, head of product management visualization for Siemens Digital Industries Software.

An impressive array of application areas for the industrial metaverse are emerging. Here is the new capabilities enabled will be relevant for a wide variety of industries, from manufacturing and transportation to offices and urban development. Here are just a few examples of use cases we expect for industry.

Improved design and engineering Team members from disparate disciplines, functions, and even industries will be able to work together to design, design new products, and gain real-time insight in a collaborative setting, without the need for time-consuming, costly, and resource-intensive travel in multiple physical prototype development. Moreover, the industrial metaverse brings the ability to design distributed teams across disciplines to contribute readily to a project, enabling everyone to become an innovator without the risks and costs associated with real-world mistakes.

More extensive testing and validation By combining photorealistic environments with multi-physics simulations, industries can test a wide range of number

"You can find a use case anywhere in the industrial life cycle and make it better with industrial metaverse."

Ian Fisher, Head of Product Management Visualization, Siemens Digital Industries Software

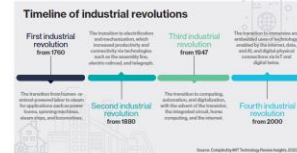
of scenarios while training and enabling autonomous systems through machine learning and synthetic data. This might result in faster development of a new product, a more efficient design of new facilities, or an early integration of circular economy principles into designs.

Virtual commissioning Using a virtual model of a manufacturing system can build redundancy, helping to detect and correct early errors in the design and software without disrupting ongoing production lines or needing physical resources.

Enhanced operations By simulating a factory or other workplace, team members can collect data in a digital world – information that can be used to support a wide range of its application use cases, such as virtual factory planning, autonomous robots, predictive maintenance, and data analysis. Furthermore, continuous real-time representations will support frontline workers and improve the efficiency of their real-world operations.

Access to talent and training In today's tight labor market, organizations often find it hard to find talent due to a lack of access to training and career development. The good news is that "the opportunities afforded by the metaverse to upskill skills and to provide training on daily updates," says Fisher. "Such because the metaverse can offer employees remote access to expert skills and virtual training modules regardless of their physical location. In the future, these technologies may help ease labor shortages in an urgent society."

In the industrial metaverse, next-generation digital twins will represent everything from whole manufacturing plants and transportation networks to growing cities and highly complex human systems. By representing the physical and digital worlds, the industrial metaverse will not only change how organizations operate and employees work but will also unlock significant benefits for society through their sustainability and enhance human life.



- improved design & engineering
- more extensive testing and validation
- virtual commissioning
- enhanced operations
- access to talent and training



Design & Engineering

- Interaktive Simulationen durchführen
- Kollaborativ auswerten



Betrieb

- Visualisierung von Arbeitsabläufen und Daten
- Fernsteuerung
- Fernwartung



Virtual Testing & Validation

- Nutzung von fotorealistischen Umgebungen für synthetische Daten



Training

- Für ungewöhnliche oder kostspielige Szenarien
- Durch Experten aus der Ferne



Produktion

- Virtuelle Inbetriebnahme
- Bewertung der Auswirkung von neuen Geräten oder Software

benefit & use cases metaverse



	Training & onboarding	Design & testing	Production & delivery	Service & support
Industrial	XR hands-on training	- XR-enhanced UX research - Virtual R&D, prototyping and testing	- Supply chain, grid or network planning and optimization - Facility planning and optimization - Autonomous/RC operations robotics	- Field XR - Visualized predictive maintenance - Autonomous/RC maintenance robotics
Enterprise	- Virtual recruiting and hiring - XR onboarding and soft-skills training	Virtual office and workspaces	- Virtual showroom* - Virtual product and service trials*	Metaverse-enhanced customer support*

□ Non-customer-facing use cases, covered in detail throughout the report ■ *Customer-facing enterprise use cases covered in less detail throughout the report



Use cases		
Training	In-person training, video content and text are the prevailing methods for teaching and training. XR pilot use cases trial training in predefined virtual learning scenarios. Increasing effectiveness of (remote) training in realistic, immersive, highly manipulative, virtual environments. Multi-user interaction and automated supervision becomes possible.	
Development and testing	Products and factories are planned digitally in 3D and accessed with 2D monitors, simulation and tests with few parameters are possible. Increasingly complex products and factories can be simulated and tested, minimizing the need for physical prototyping and testing. AI-supported asset generation and (remote) real-time collaboration with customers and suppliers becomes possible.	
Monitoring, operations and assembly	Real-time digital operation and monitoring of production systems.	Increasing automation and digital twinning of production systems with AR assisted assembly. Increasingly autonomous production systems enable remote monitoring and control, are assisted by AI and can be intuitively visualized in XR.
Business intelligence	Data are analysed in an aggregated manner in different systems, AI is explored for decision support. Enhancement of visual analytics with AI and internal and external data, voice input.	
Marketing and sales	Industry mainly uses physical product demonstrations in-person or through videos, pictures and text. Cost for immersive content creation is still high.	Increasingly immersive 3D presentations of products or factories in 3D showrooms that are accessible with XR and created in no-code development tools.
Customer support	In-person or remote expert assistance via audio or video are predominant in industry.	Increasing use of remote customer support for physical maintenance with a shared perception of space through XR or holographic instructions.



Virtual worlds are attracting great attention in business and society under the term "metaverse"

The impact on the economy and society is considered to be substantial:

- forecast of metaverse markets of up to USD 394 billion by 2025 (BCG) and USD 5 trillion by 2030 (McKinsey)

XR in Germany:

- 60,000 people in over 1,600 XR companies generated sales of up to € 550 million in 2022, according to Cologne University of Applied Sciences with sales growth of around 30% (despite coronavirus!). (2012; Prognos analysis; other research method said: even more than 2,500 of 3D-companies in Germany)
- start-up activity in the XR market is encouraging, with four times as many start-ups as closures since 2019.
- XR sector is characterized by many small and medium-sized companies -> creating many jobs

⇒ virtual worlds are a highly relevant topic for us

⇒ virtual worlds hold the potential for value creation and jobs in Germany

⇒ they enable new business models in existing and emerging industries.

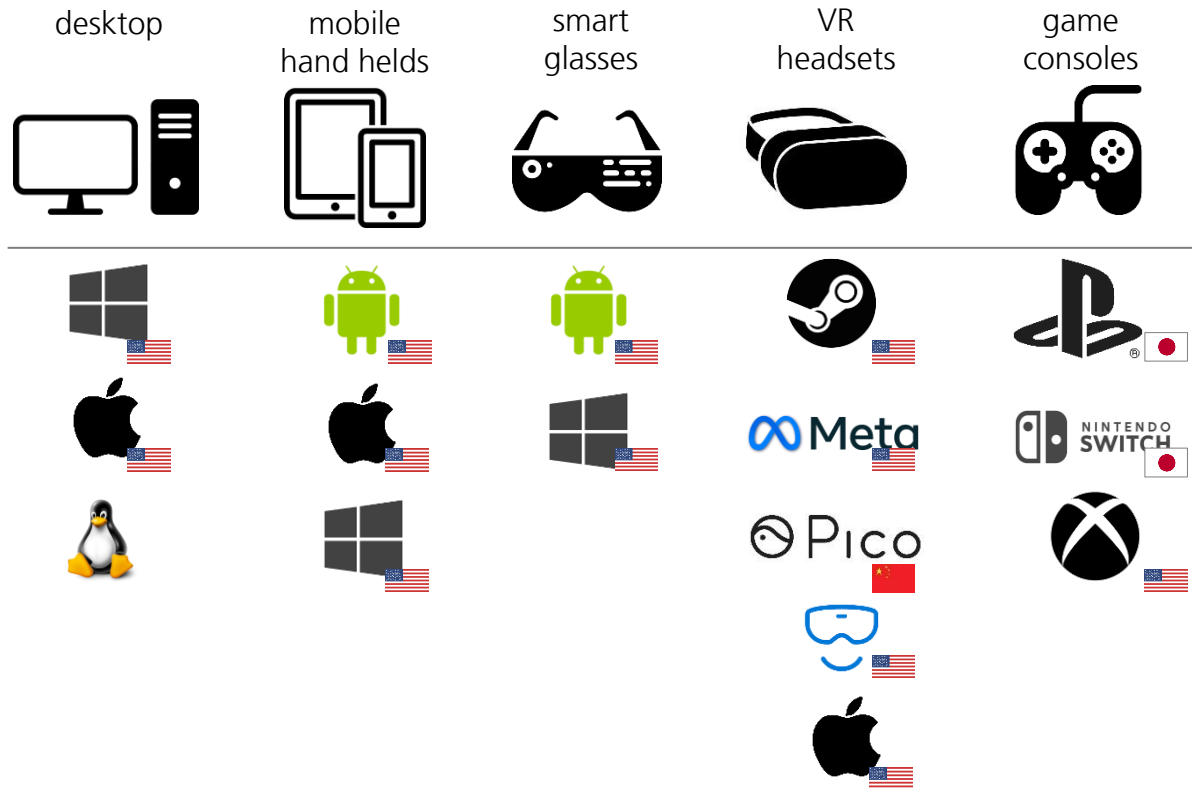
⇒ they are essential for the long-term interoperability and connectivity of our traditional industries.

Europe finds itself only at the sideline of a fight for global XR ecosystems.

problem:

- Europe does not provide a huge, global platform provider
- platform providers aim at vendor lock-in

⇒ standardization and regulation could be valid options for us



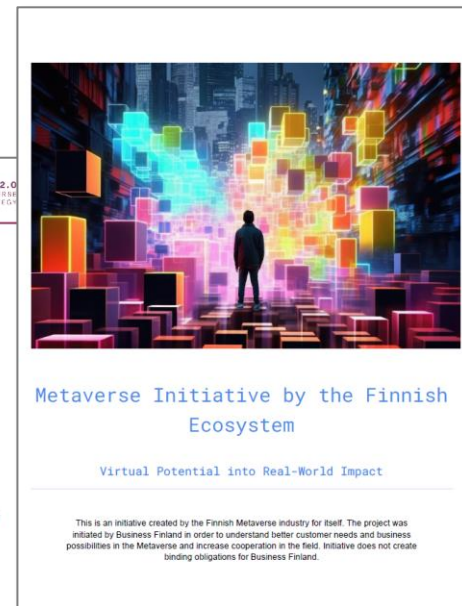
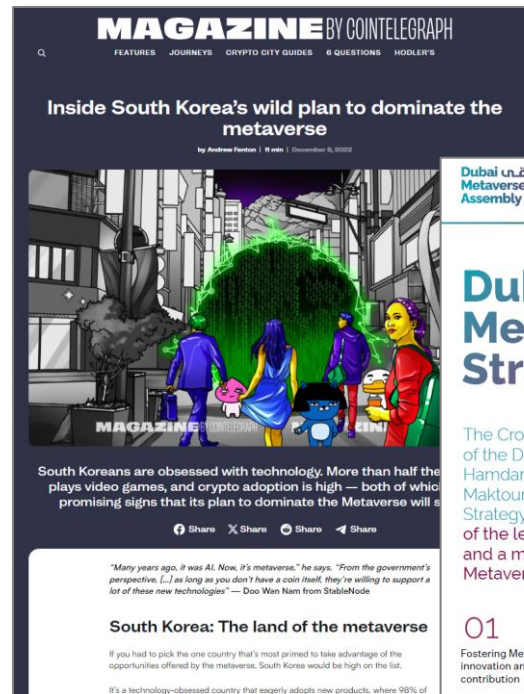


Perspectives to other Countries

Other countries are going ahead

Other countries

- identified economic potential and
- started initiatives
- some of the strategies appear ambitious to almost aggressive



China



Table of contents

- (i) Development of an advanced technological and industrial system for the metaverse
- (ii) Promotion of an interactive, 3D industrial metaverse
- (iii) Creating immersive and interactive applications for digital life
- (iv) Development of systematic and comprehensive industrial support
- (v) Establishment of a secure and trustworthy industrial governance system
- V. Security measures
 - (i) Strengthening integration and coordination
 - (ii) Optimizing talent development
 - (iii) Deepening international cooperation

"Three-Year Action Plan for the Industrial Innovation and Development of the Metaverse (2023-2025)"

5 key tasks

1. Building advanced metaverse technologies and industrial systems
2. Cultivating a three-dimensional and interactive industrial metaverse
3. Creating immersive interactive digital life applications
4. Establishing comprehensive industrial support
5. Constructing a secure and trustworthy governance system

14 specific measures, each tailored to address unique aspects of metaverse development

4 major initiatives that span

1. key technological enhancements
2. ecosystem cultivation
3. industrial empowerment and
4. foundation strengthening

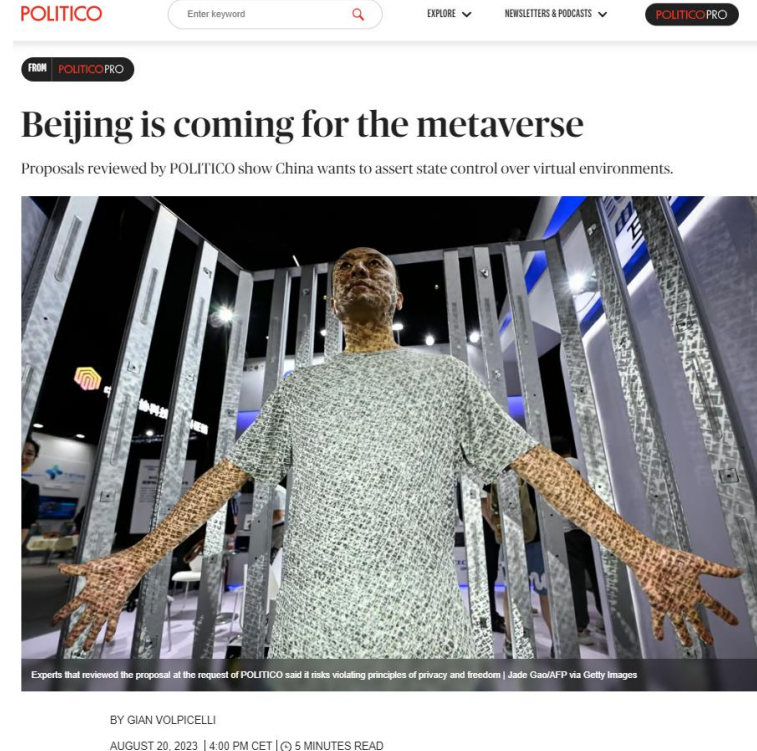


Chris Kremidas-Courtney, senior fellow at Brussels think tank „Friends of Europe“ and Lecturer for Institute for Security Governance (ISG) in Monterey, California.

He said that China plans to “*be the world leader in metaverse development,*” a technology that dovetails with its plan for a state-controlled digital renminbi. Standard-setting is the natural first step in that roadmap.

“If you want to seize the future, you set the standards for it”

Chris said.





EU Strategy on „Virtual Worlds“



The European Commission have adopted a strategy on Web 4.0 and virtual worlds to steer the next technological transition and ensure an open, secure, trustworthy, fair and inclusive digital environment for EU citizens, businesses and public.c administrations.

3.1. People and skills

3.1.1. Building a talent pool of virtual world specialists

3.1.2. Virtual worlds toolbox for the general public

3.1.3. Empowered and protected children in virtual worlds

3.2. Business: supporting a European Web 4.0 industrial ecosystem

3.2.1. Boosting the EU's technological capabilities

3.2.2. Accelerating the uptake of new business models and solutions

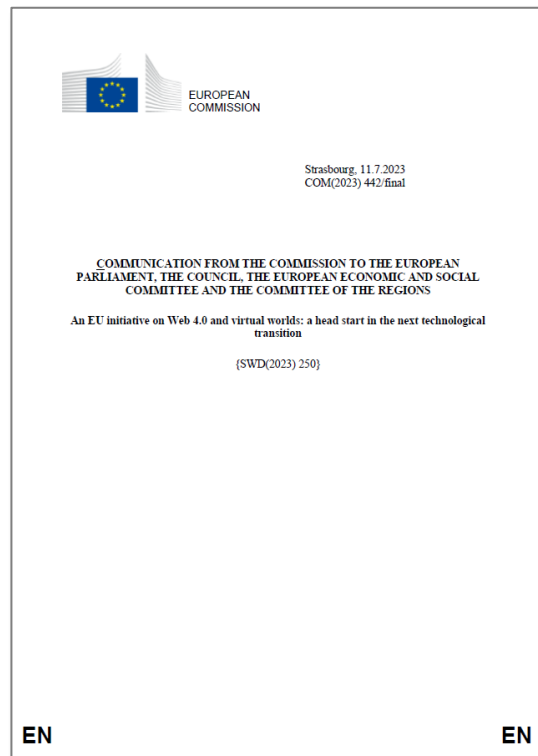
3.2.3. Fostering a supportive business environment

3.3. Government: supporting societal progress and improving public services

3.4. Governance

3.4.1. Governance at the EU and global level

3.4.2. Monitoring the development of virtual worlds and Web 4.0



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Our Metaverse Options for Action

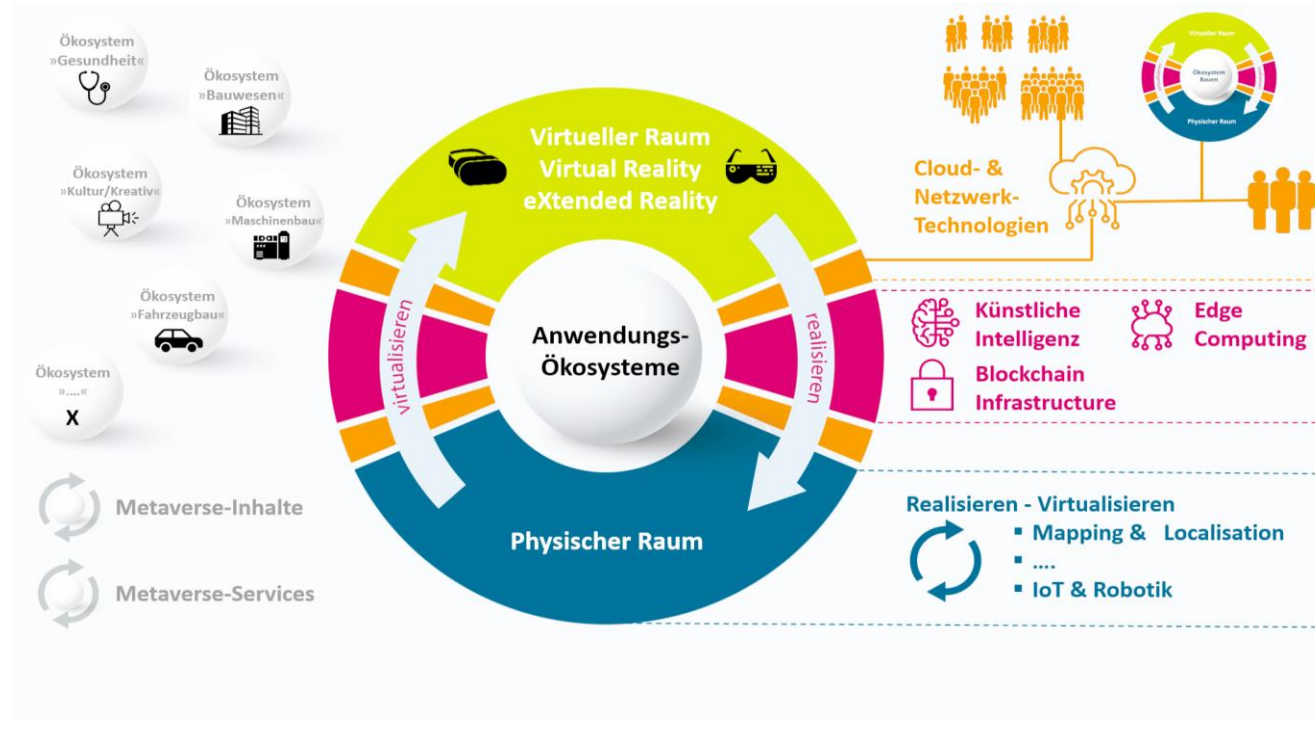


The Metaverse Tech Stack

The Metaverse Tech Stack is full of our competencies

- VR, AR, MR, XR
- cloud + edge computing
- artificial intelligence
- real world – virtual world synchronization, e.g. mapping, localization, sensors, automation,...
- specific domain knowledge of application areas

⇒ **we can build products, services, components for MV**

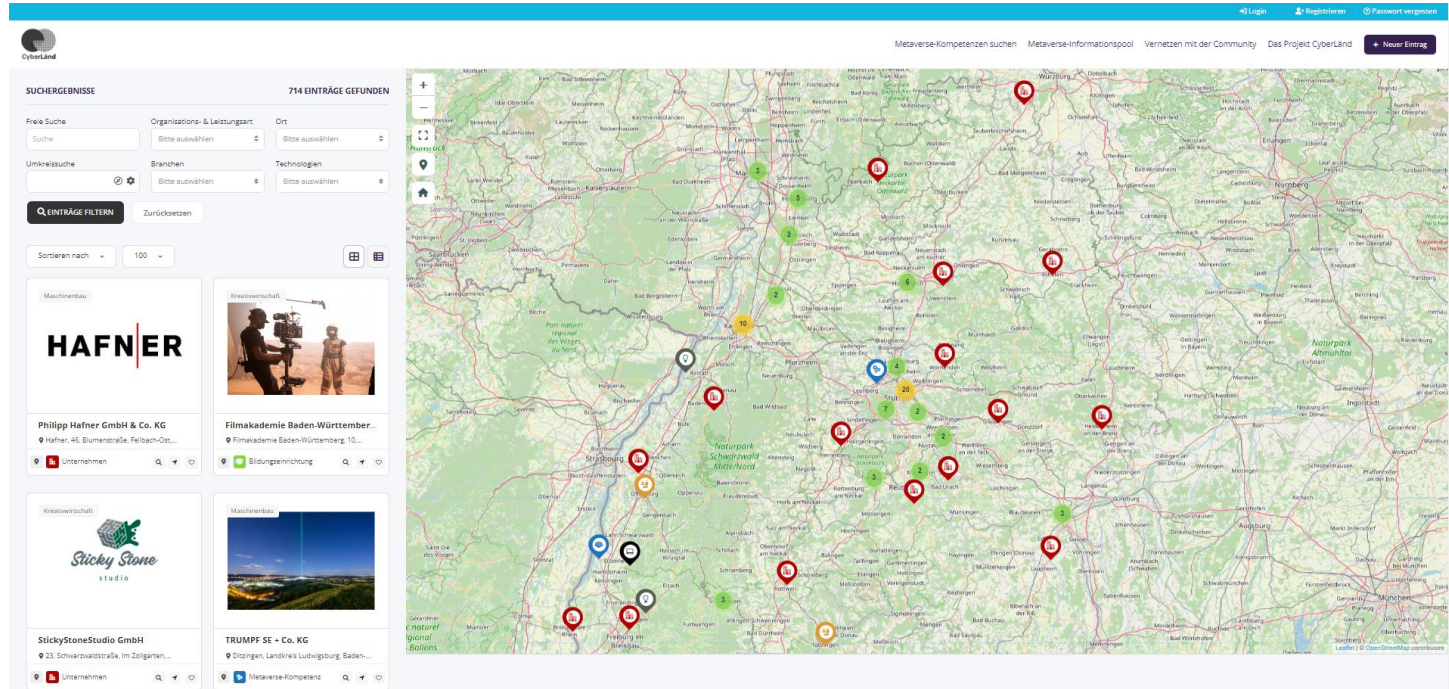


Baden-Württemberg Metaverse Competence Map: 700+ entries

entries are MV-related

- companies
- research labs
- consultants, attorneys
- educations & trainings
- events
- best practices
- ...

⇒ we have a good stock of expertise

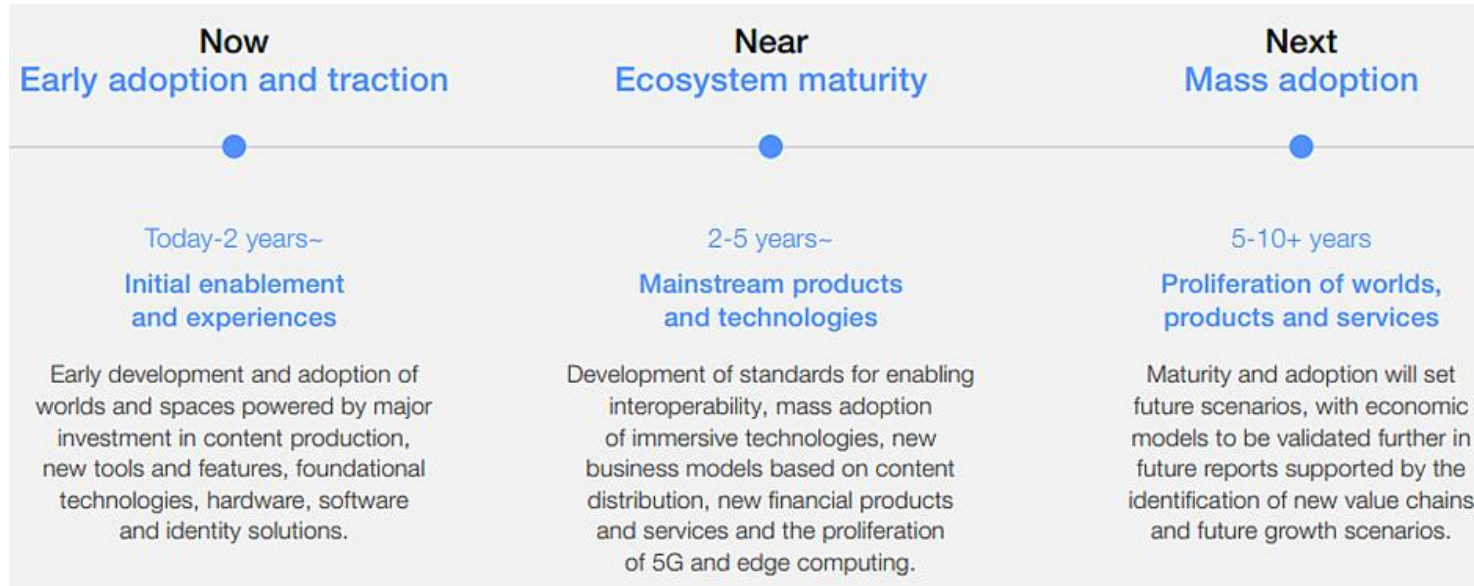


Projected horizons of metaverse growth and adoption

Metaverses are
in the making



<https://www.weforum.org/agenda/2023/02/metaverse-use-cases-industrial-consumer-enterprise/>





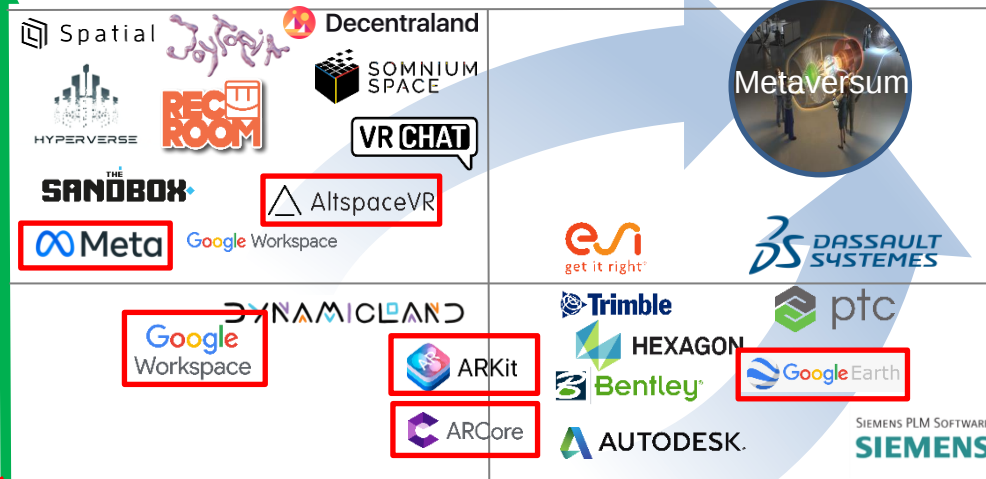
Who will realize useful Metaverses?

Big tech and well-known Metaverse companies:

- can build platforms
- can build XR devices
- will probably not be able to fill their metaverses with professional content

collective spaces

distributed-collaborative V/AR;
decentral data storage;
Web3.0 / blockchain



Metaversum

digital twin

competences
on capture,
planning,
design,
assistance

seamless
interaction spaces

hardware competency



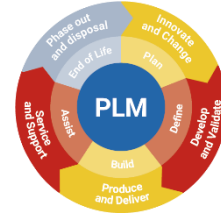
Digital Twinning: twin platforms

thousands of solutions from the most diverse industries with the most diverse technologies and concepts but the same goal: Mapping the physical reality in the model

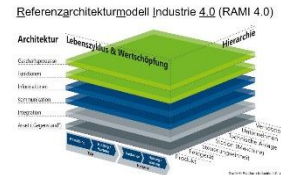
⇒ **those should be the Metaverse data base**



INDUSTRIAL
INTERNET
OF THINGS



Digitale Fabrik



IDTA
Industrial
Digital
Twin
Association

INDUSTRIE 4.0



Digital Twinning: sensing and tracking

thousands of solutions from the most diverse industries with the most diverse technologies and concepts but the same goal:

Mapping the physical reality in the model

Subfield Tracking, Positioning:

- hundreds of providers
- 20+ technologies
- from photogrammetry with smartphone cameras to satellite positioning
- convergence (sensor fusion) will deliver seamless indoor and outdoor positioning

⇒ **Many from Europe and Germany**

⇒ **We can deliver components and products**



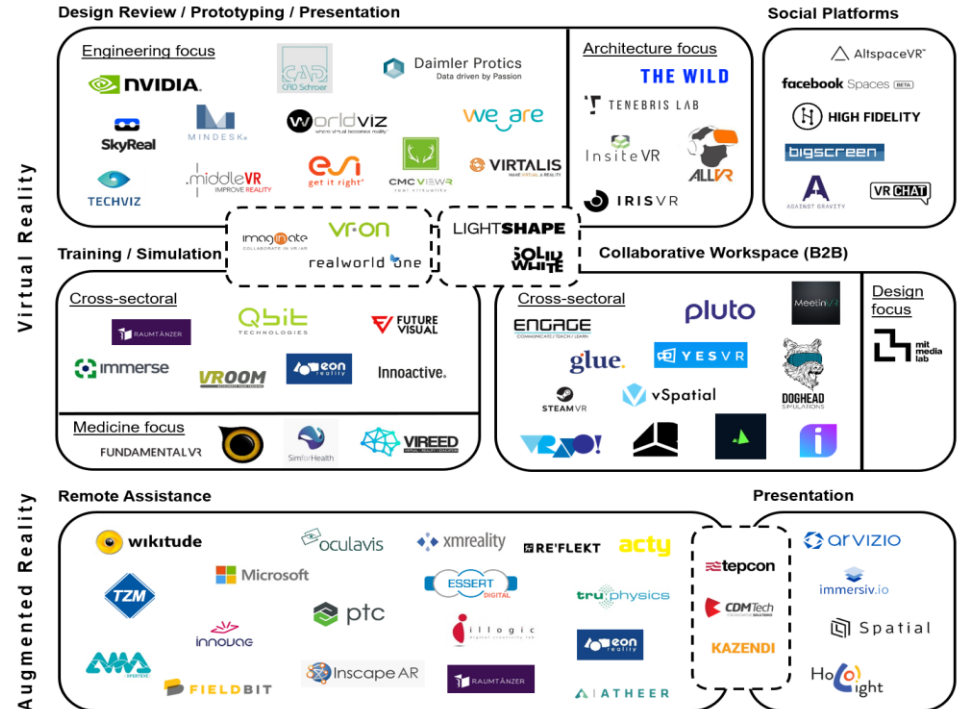


Collaborative XR environments, with rules, ethics, ownership, safety and security

XR collaboration platforms

- hundreds of solutions worldwide
- VR and AR
- partly application- or industry-orientated, partly consumer solutions

⇒ **we are not starting from scratch**



from
2021

Is there any opportunity for us?

Analysis by EY and NOKIA (2023)

Who will drive the industrial metaverse?

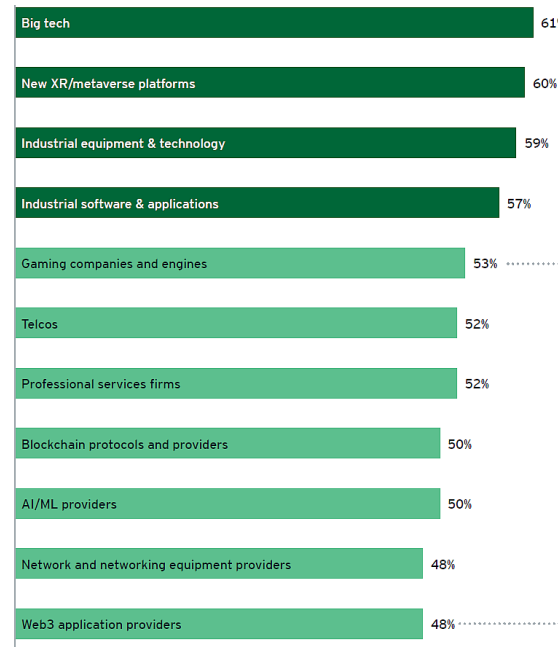
It will not only be

1. the big tech companies (1st place) and
 2. existing metaverse platforms (2nd place) that will drive future metaverse developments,
- but also
3. industrial equipment suppliers (3rd place),
 4. manufacturers of enterprise software (4th place) and
 5. game developers (5th place).

These are industries that have a strong position and tradition in Germany.

⇒ **we can be the drivers**

Key Players in driving the advancement of the metaverse



Big tech companies are already engrained in the infrastructure of the metaverse through their existing cloud services and visualization tools, while also investing heavily to create new metaverse platforms and AR/VR headsets.

Gaming companies and engines play a key role in the early metaverse by providing the technology needed to make high-fidelity virtual environments like digital twins. Many of the features needed for the industrial and enterprise metaverses like advanced 3D graphics and physics engines have been in development for over a decade in gaming companies.

Web3 application providers, while not ranked as highly as other players, are still viewed as important by nearly half of respondents for their ability to handle many of the new challenges metaverse technology will bring. Challenges in user authentication across companies, for example, can be solved with the use of decentralized identities (DIDs).

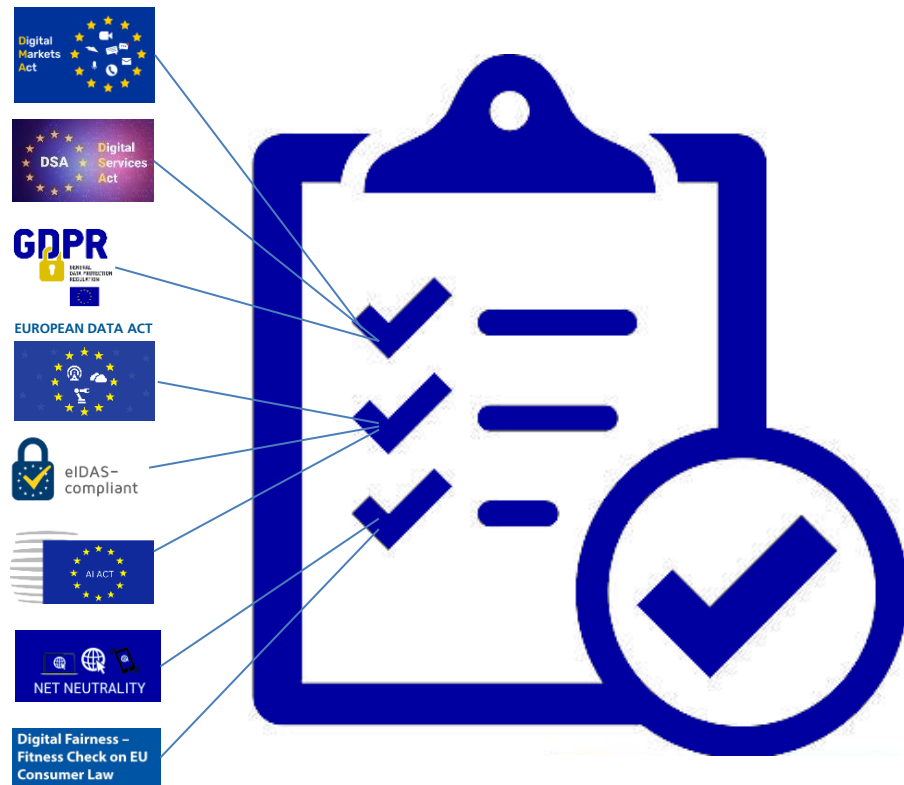


A EU regulation compliant Metaverse platform

Shall the metaverse be regulated?

- senseless question:
it is already regulated
- we need a fully compliant
MV platform

⇒ **We should take up the great challenge of building local platforms**





More to come: European Partnership on Virtual Worlds



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Research and innovation

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NEWS ARTICLE | 17 July 2023 | Directorate-General for Research and Innovation | 2 min read

Commission proposals for new candidate European Partnerships are now public

Preparations of new European Partnerships that will be launched during the second half of Horizon Europe have reached an important milestone this week, when the European Commission presented [10 proposals for new candidate partnerships](#) to Member States and Associated Countries:

- Brain Health;
- Forests and Forestry for a Sustainable Future;
- Innovative Materials for EU (IM for EU);
- In-Orbit Demonstration and Validation;
- Raw Materials for the Green and Digital Transition;
- Resilient Cultural Heritage;
- Social Transformations and Resilience;
- Solar Photovoltaics;
- Textiles of the Future;
- Virtual Worlds.

This proposed portfolio will be discussed with Member States and Associated

...

So what we should do now:

- network the community, build trustworthy cooperations and value chains
- identify the opportunities of metaverse by each relevant stakeholder
- build products, services, components for the metaverse
- enforce metaverse standardization –
let's connect the metaverses to the our big data platforms that map digital twins
- fill the metaverses with our 3D contents: from our products, houses, factories, cities, ...
Of course with suitable IP protection and a good business model for us.
- build metaverse platforms fully compliant to EU regulations
- let's be the drivers of the metaverse - let's take great challenge of building local platforms

This could be part of our German Metaverse Strategy.



Industrial Metaverse Chancen für die Photonic und Quantentechnologien?

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Berlin, 11. Juni 2024**

Thank you very much for your attention.

Prof. Dr.-Ing. Dipl.-Kfm. Christoph Runde

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