# Virtual Worlds for Manufacturing

Prof. Dr. Christoph Paul Runde
Virtual Dimension Center (VDC) | XR EXPO | DIN | MSF

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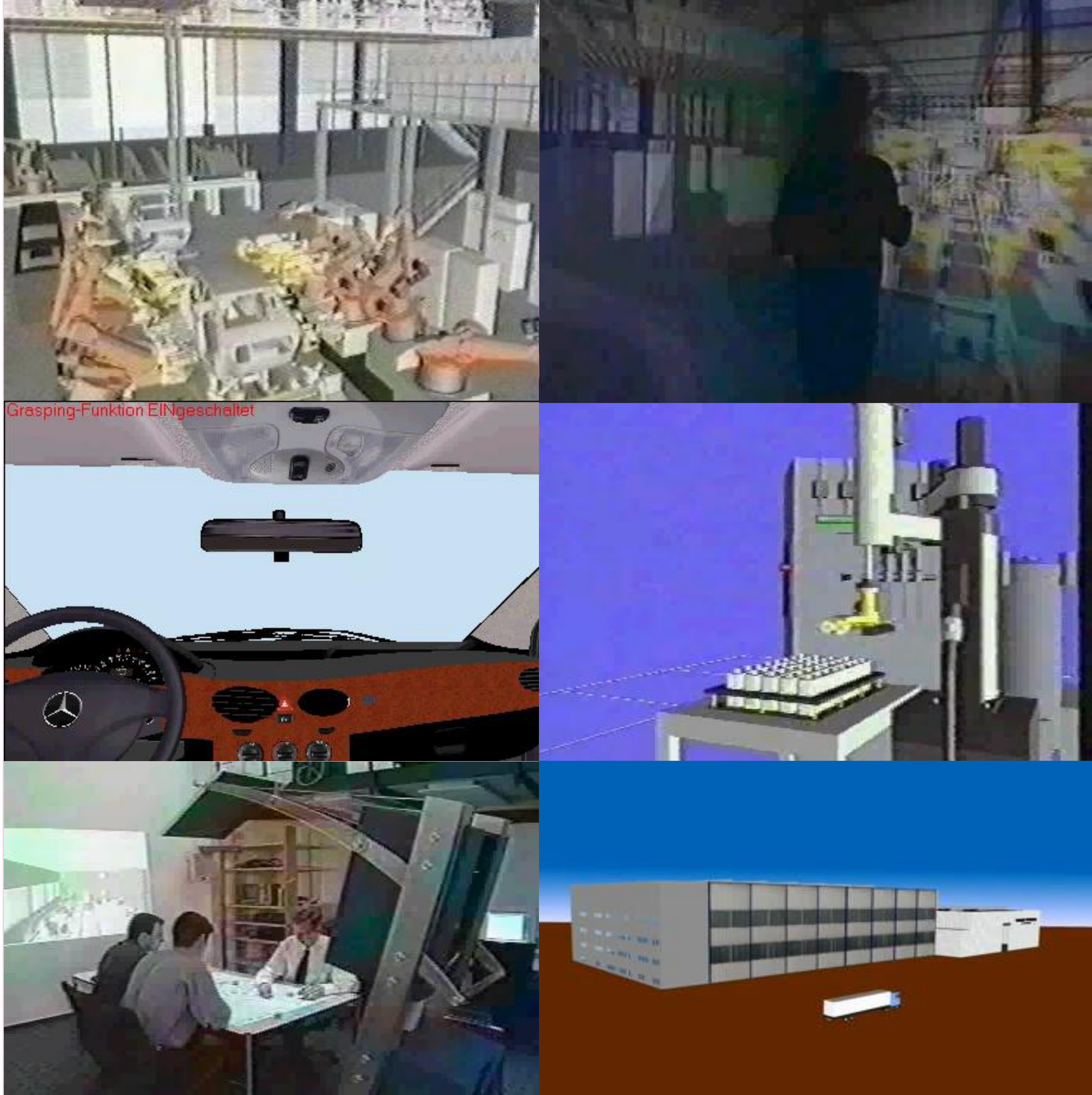
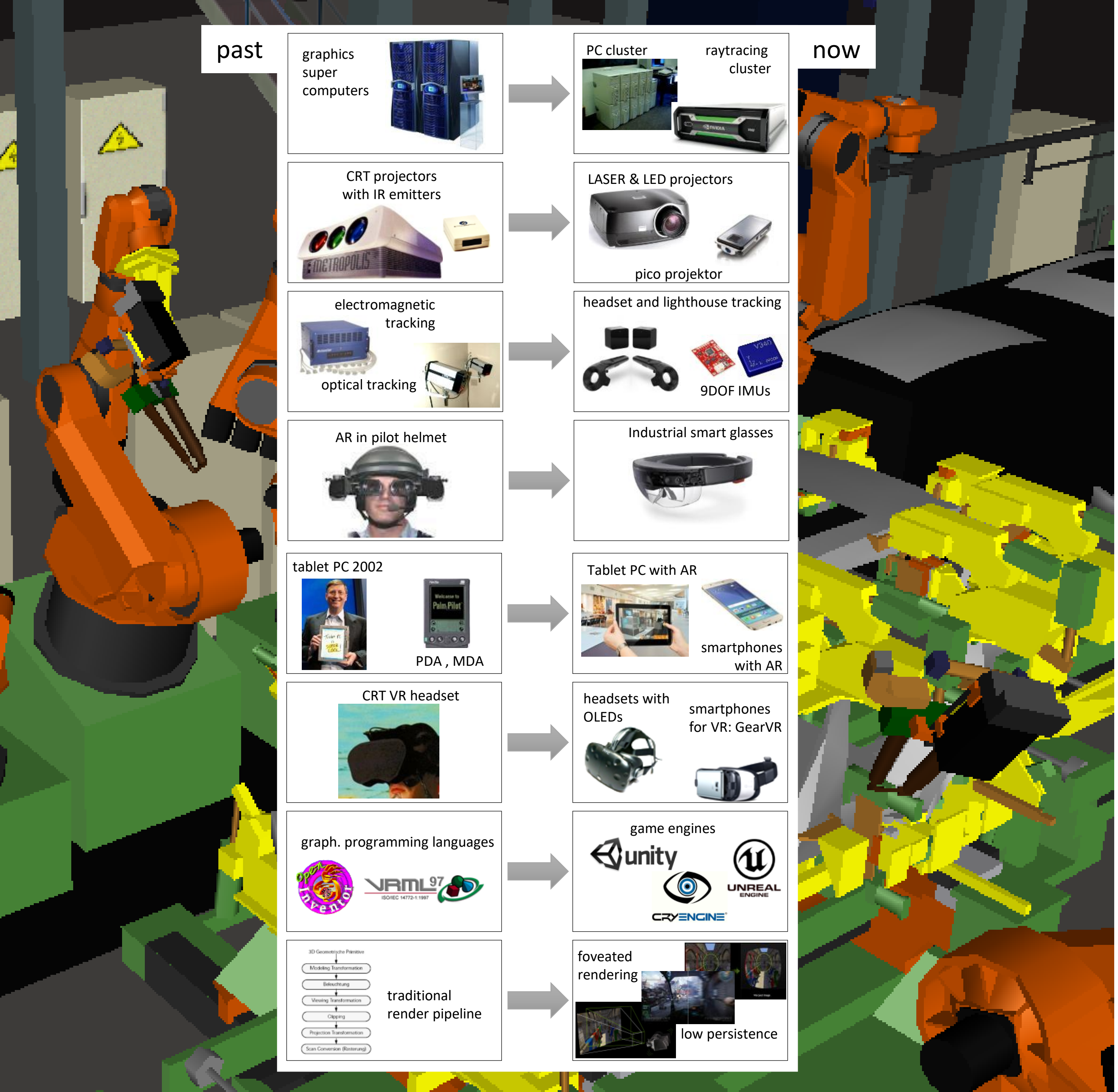
# Virtual Manufacturing has a long history

- videos are from my work 1995 at the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA), Stuttgart
- main goal: virtual prototyping of factories and all incorporated processes
- very expensive graphics computers (sgi machines) and very huge effort for 3D data processing coming from CAD
- own written simulators for robots and PLCs (programmable logic controls) at that times








# What has changed since then?

- massive hardware advancements, pushed by mobile phone technologies (processors, displays, sensors, batteries, …) and by the gaming sector (graphic cards)
- massive software advancements, pushed by the mobile phone sector (mobile apps and app shops) and the gaming sector (game engines)
- massive price degression due to these two mass markets
- massive advancements in the availability of 3D data, pushed by demands from all sectors and by technology (scanners, depth cameras, industrial CT, LiDAR, …)

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areas of application

# Digital & Virtual Manufacturing

### prototyping

enables virtual testing of products before physical production. Using virtual worlds tools, engineers can analyze form, fit, and function in real-time. This reduces development costs, shortens time-to-market, and enhances product quality by identifying design flaws early in the innovation process.

### training

via virtual worlds allows immersive, interactive learning experiences. Workers can practice complex procedures in safe, simulated environments using VR/AR. This approach improves skill acquisition, reduces training costs, minimizes downtime, and enables scalable onboarding across global sites with consistent quality and real-time performance tracking.

### assistance

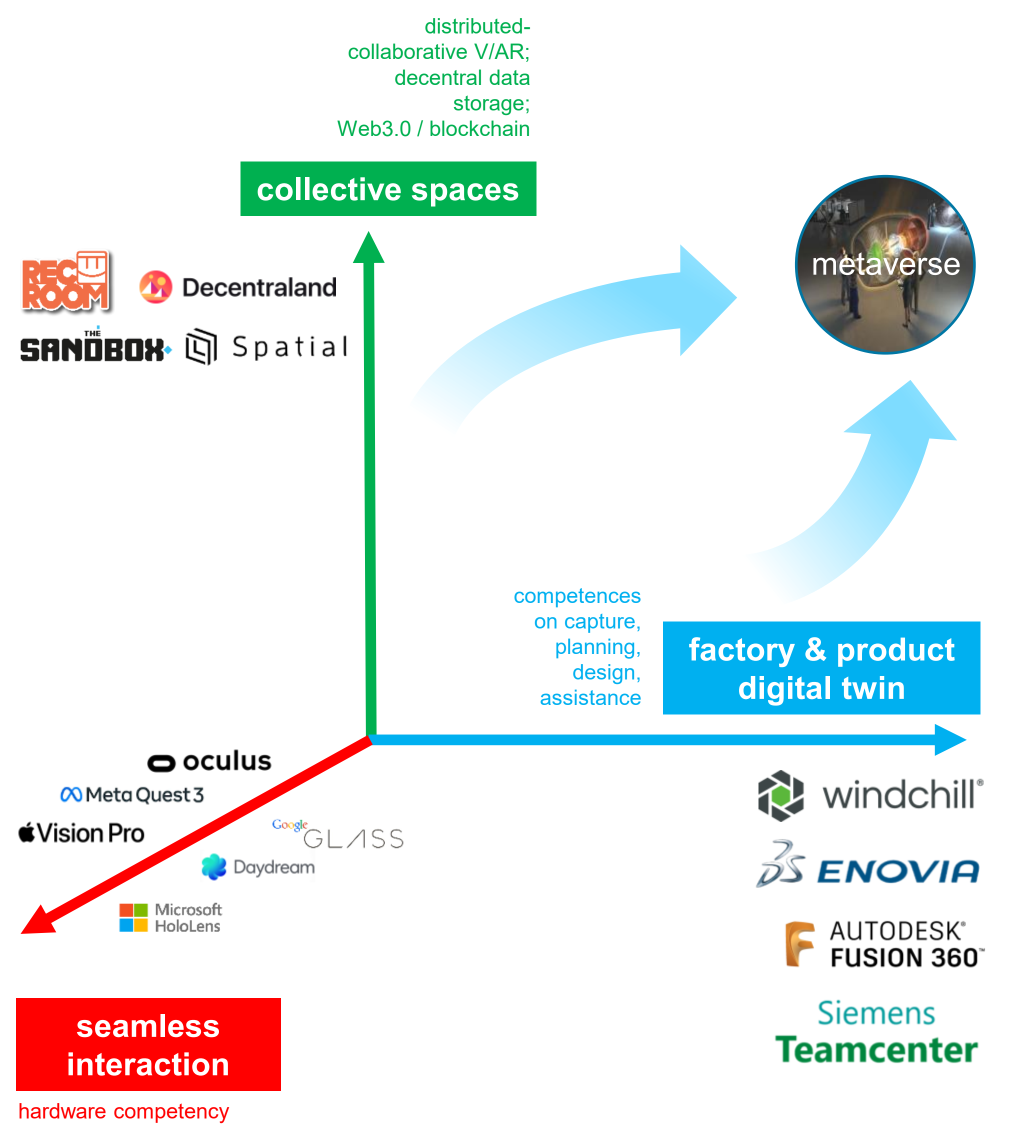
using virtual worlds or AR provide real-time guidance, visualization, and contextual information directly in the worker’s field of view. These systems enhance decision-making, reduce errors, and support complex tasks by overlaying digital instructions onto physical environments, improving productivity, safety, and knowledge retention on the shop floor.

### acceptance

in manufacturing, enhanced by virtual commissioning allows clients to experience and validate systems remotely before physical delivery. Through immersive 3D simulations and real-time data, customers can verify functionality, request adjustments, and approve installations earlier—reducing risk, travel, and commissioning time on-site.

### quality inspection

in manufacturing using AR focuses on overlaying digital 3D models onto physical components for real-time comparison. This as-is vs. as-designed alignment helps detect deviations instantly, streamlines inspections, and ensures dimensional accuracy—enhancing precision, reducing errors, and supporting faster, data-driven quality decisions on the production floor.




# Virtual Worlds will be seamless, collective spaces for digital twins

digital twinning is crucial for commercial success of virtual worlds

virtual worlds must be able both to display digital twins in real-time and to allow to manipulate them

there can be more than 1 digital twin:
e.g. future projections, planning variants

there can be virtual worlds with no physical twin:
e.g. disaster simulation

the question is how digital twins, collective 3D spaces and XR hardware platforms will converge to seamless, collective 3D spaces for twinning

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# Positioning ourselves

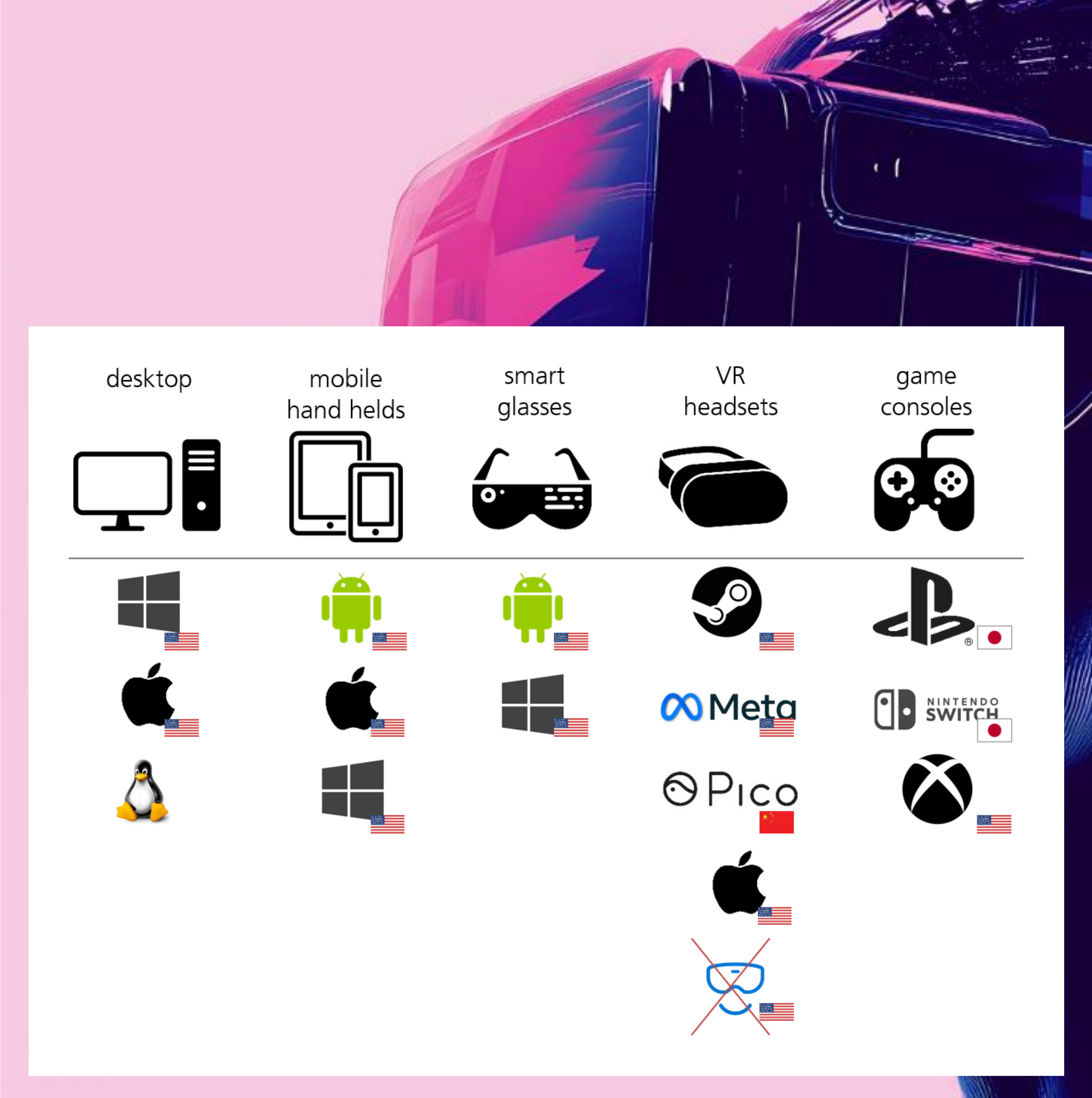
- most countries finds themselves only at the sideline of a fight for global virtual worlds eco systems
- most countries and continents do not hold a huge, global platform provider
- platform providers aim at vendor lock-in
- **standardization** and **regulation** are a very valid strategy and crucial to cope with this situation

IDTA
Industrial Digital Twin Association

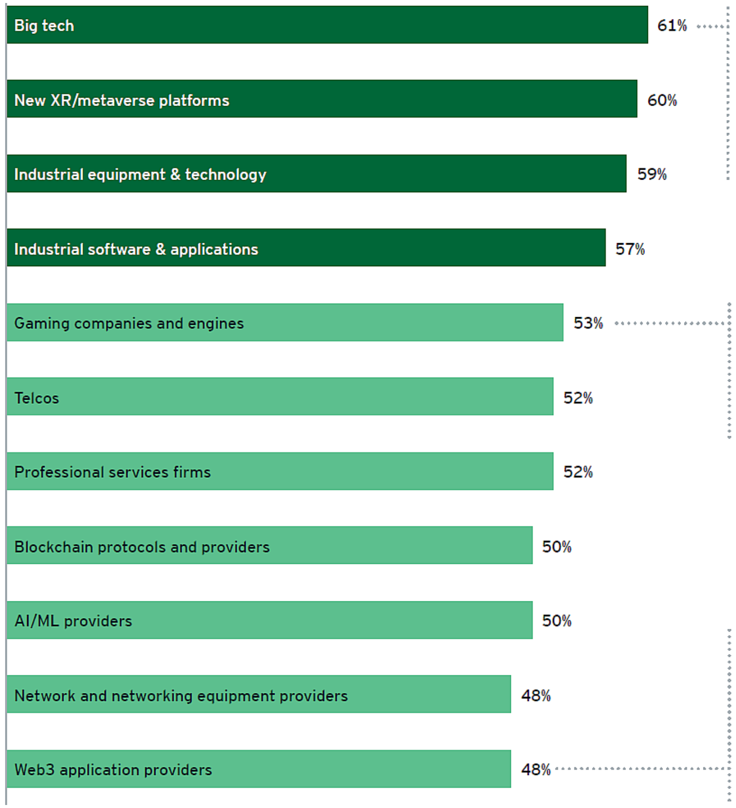
INDUSTRIE4.0

INDUSTRIAL INTERNET OF THINGS

CAM
COMPUTER AIDED MANUFACTURING

## key players in driving the advancement of the industrial 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)

EY NOKIA

https://www.nokia.com/metaverse/industrial-metaverse/the-metaverse-at-work-research/

# opportunities for countries without platform providers

**Analysis**

- by EY and NOKIA (2023)
- *"Who will drive the industrial metaverse?"*

**The drivers will not only be**

- big tech (1st place) and
- existing metaverse platforms (2nd)

**but also**

- industrial equipment suppliers (3rd),
- manufacturers of enterprise software (4th)
- game developers (5th).

**>> many countries & companies could be the drivers. Why? They have the relevant data.**

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# Strategies on virtual worlds

## countries and regions

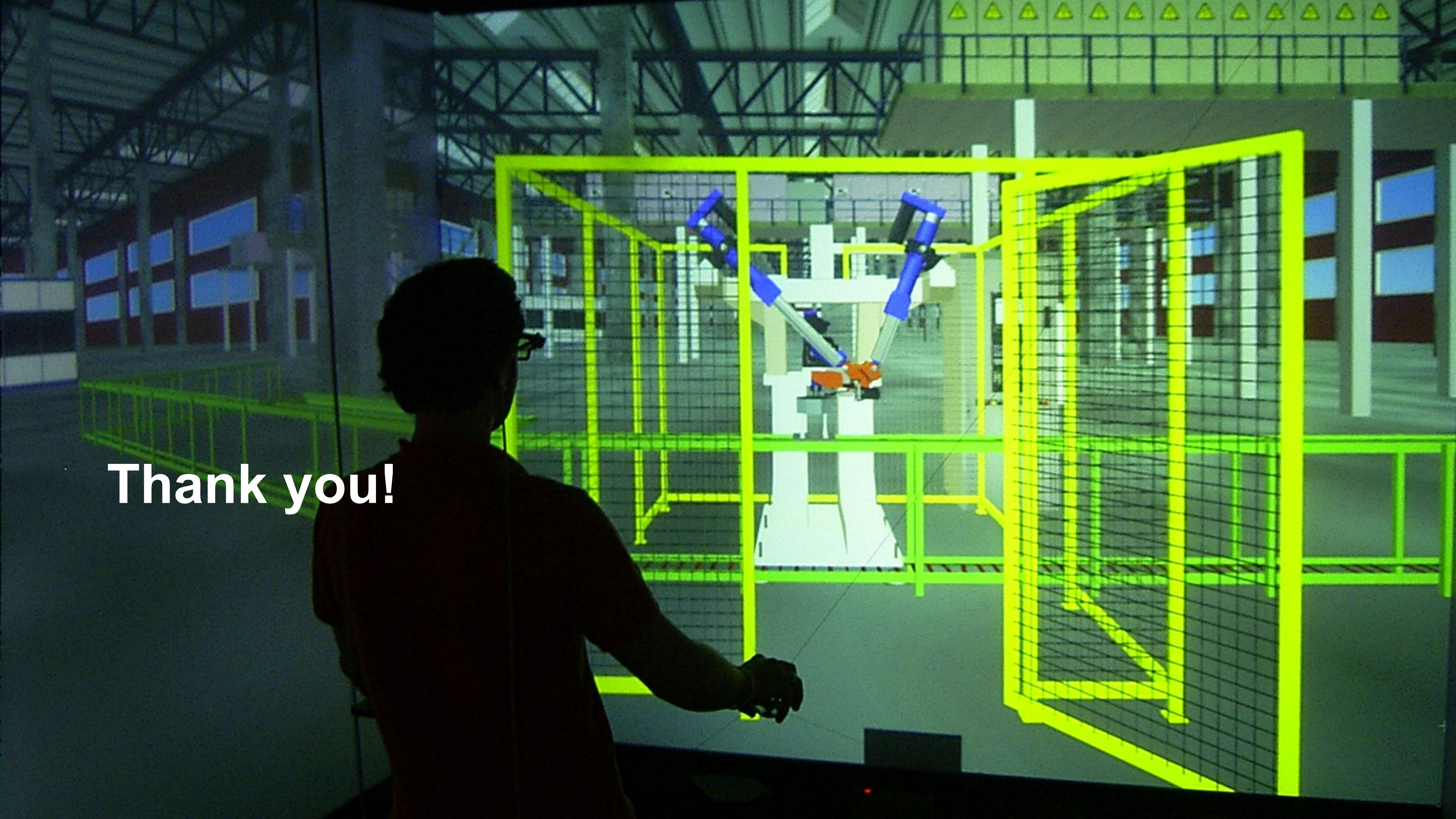
- Baden-Württemberg ,China, Dubai, the European Union, Finland, Japan, Saudia Arabia and South Korea defined metaverse strategies.
- UK and USA: strategy development ongoing

## industrial metaverse in strategy

- Baden-Württemberg, China, Europe, Finland

## standardization in strategy

- Baden-Württemberg, China, Europe, Finland


Thank you!