



Towards Sustainable Industrial Metaverse

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IoT & Digital Twin Workshop



Technology Vision 2030 on the metaverse opportunities

Concepts of 'Human Augmentation' and 'Digital-Physical Fusion' frame this vision

Metaverse enablers



Human Augmentation

Handhelds
VR HMDs
Tethered AR glasses
Haptic-enabled remote control

Connected bio-medical implants
Industrial exoskeletons
Ergonomic, untethered XR glasses
XR interoperability



Digital-Physical Fusion

Basic, organization-level digital twins
Smart sensor networks
Persistent virtual worlds & objects

Complex, enterprise-wide digital twins
Ecosystem interoperability
Interactive 3D digital twins

Metaverse opportunities

Consumer Metaverse



Enterprise Metaverse
(IT-centric)



Industrial Metaverse
(OT-centric)



~ today



~ 2030

* Virtual Reality Head-Mounted Displays

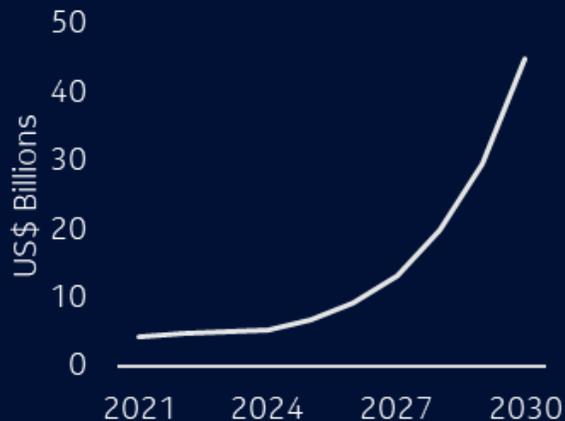
** Augmented Reality

*** Extended Reality

Industry is expected to lead Metaverse commercialization

Consumer Metaverse

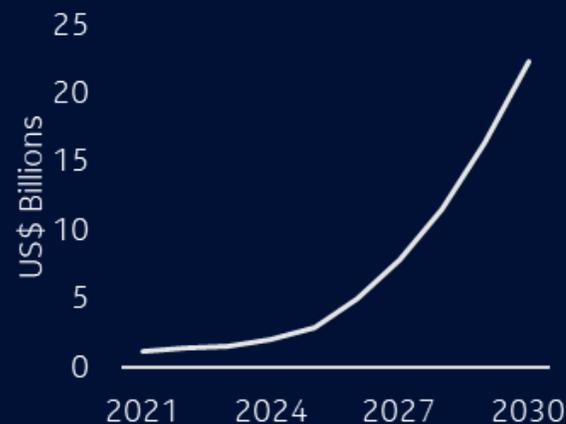
Virtual Spaces Revenue (Global)¹



- Consumer appeal driven
- Reliant on trends and network effect
- Fragmented monetization, with growth from ~2026

Enterprise Metaverse

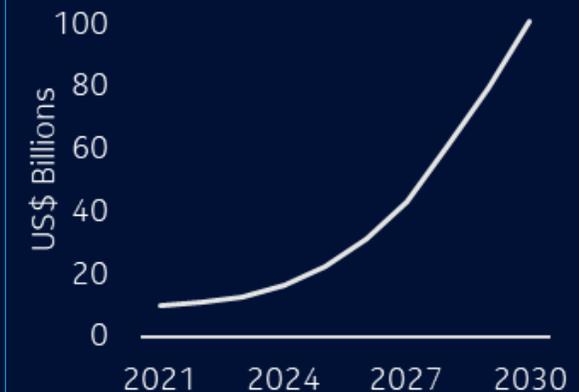
Immersive Collaboration and Related Cloud Revenue (Global)²



- Business value driven
- Solution & device innovation
- Good monetization potential, with growth from ~2025

Industrial Metaverse

Digital Twin & Simulation and Industrial XR Revenue (Global)³



- Operational results driven
- Industrial automation focus
- High monetization potential, with early traction

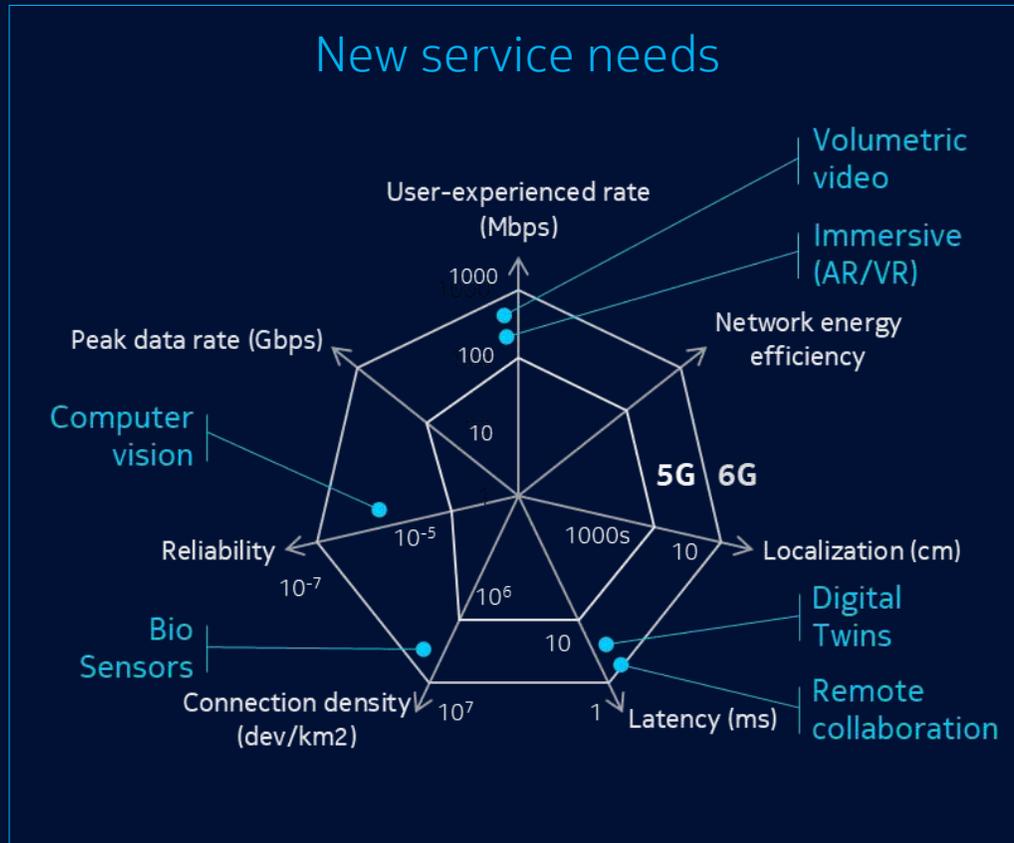
1 ABI Research: 2022 Consumer Metaverse Market Update, June 2022

2 ABI Research: Enterprise Metaverse: Future of Work, March 2022

3 ABI Research: The Future of Work, Augmented and Mixed Reality, Virtual Reality Market Data, November 2022

Triple Challenge - New service needs, security and cost of energy

... requiring interoperability and standardization



Cost of Energy

According to GSMA Intelligence, energy consumption accounted for between 15% and 40% of teleoperators' OPEX in 2021 and is expected to heavily increase in 2022 onwards.

The energy costs associated with running the world's mobile networks are expected to exceed 24 B€ annually due to the ongoing energy crisis and inflation. Estimated annual increase of energy cost will be 8-12 %

Source: GSMA Intelligence & Telecommunications, 2021

Security

Global cyberattacks increased by 38% in 2022, compared to 2021. Global cybercrime costs are estimated to grow by 15 percent per year over during the coming years, reaching 10 trillion euros annually by 2025

Source: Check Point Research (CPR) & Cybersecurity Ventures, 2021

Our approach – Call for ecosystem collaboration

Building the core capabilities for sustainable industrial metaverse

Main focus areas

1
Technology enablers for industrial metaverse

Define and build new hardware and software enablers for the industrial metaverse architecture, platforms and use cases

2
Architecture and platforms for sustainable industrial metaverse

Build essential capabilities to enable networks and platform's security, energy efficiency and optimal performance

3
AI/ML-enabled industrial applications

Create and validate future capabilities for real-time XR media communication and industrial applications

4
Industrial Metaverse ecosystem, new business opportunities and commercialization

Lead activities to build the Industrial Metaverse Ecosystem to accelerate global business opportunity development and commercialization

NOKIA