CALL FOR EXPRESSION OF INTEREST on future visions and research directions 2025-27 in the area of Cloud-to-Edge-to-IoT for European Data

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Motivation

Lately, we have met the term metaverse on various business videos and in demos. The environments presented have been magnificently built, and they have felt very realistic. Currently, the discussion mainly focuses on the world of entertainment and consumer applications. But could the biggest unidentified potential actually lie in the world of daily work? At VTT, we are particularly interested in industrial work that involves more than sitting at a computer. This expression of interest letter focuses on how the Cloud to Edge continuum could be further developed towards high impact in the several industrial sectors as a fundamental piece in the transformation of industrial work. At VTT, we call this industrial metaverse, meaning the metaverse technologies that are empowering the industrial work in all human-centric domains.

Due to the fourth industrial revolution (Industry 4.0), novel technologies are emerging in workplaces. Now we are focusing on Industry 5.0[1] and therefore pursuing towards social, environmental, and societal considerations instead of a pure profit-driven approach. These changes create new demands for the workforce, such as managing task complexity and cognitive load at work. Simultaneously, the change provides opportunities to enrich the work and better support workers' performance. For example, hybrid work practices or ensuring effortless decision-making with the help of artificial intelligence (AI) can create more flexibility. Trends like global knowledge scarcity, the interconnected and digital world, the ageing population and generational change, and the transformation of work pave the way for new working methods.

The industrial metaverse could radically change the way industrial work is done. It could impact particularly hands-on work in labour-intensive domains, from manufacturing to construction, logistics and maintenance. The industrial metaverse could help resolve the labour crisis prevalent in all industrial nations with ageing populations and a lack of appeal in industrial work. It could expand autonomy, merge virtual and physical worlds, and bring place and time-independent work to all industrial/professional domains. The industrial metaverse could provide an immersive workspace for human-technology collaboration.

Current Status

In addition to the numerous metaverse related technology research projects, VTT has recently concluded the first human-driven industrial metaverse project[2] with 11 companies from different industrial sectors in Finland. Through this project, it has become even clearer that industrial work is undergoing transformation and companies are ready to change the way they operate. It has also confirmed our assumption that there are many common factors in the work carried out in different industrial sectors. Such cross-sectoral challenges can thus be turned into opportunities for solution providers to offer their services to a wider market. The current challenge is that the existing solutions have been built to very specific needs, often because of an urgent need such as Covid-19. The solution provider companies are also often small. Many of the needed technology pieces already exist but the integrations, implementations, and further development still needs more radical thinking to the way industrial work will change, e.g. the work roles, work tasks, and organization models, without forgetting how the solutions can be adopted by the end users even in smaller companies.

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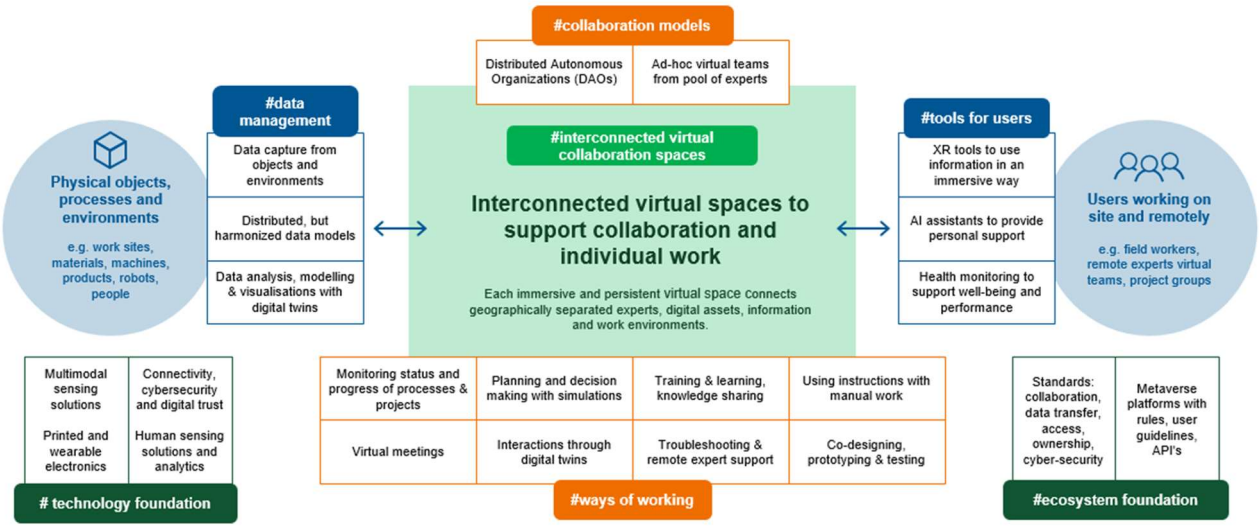
[1] https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en
[2] https://www.vttresearch.com/en/news-and-ideas/new-technologies-and-operating-practices-will-transform-industrial-work-coming-years

Research Challenges

Industrial metaverse brings the physical and virtual work environments together and enables collaborative use of novel tools and shared practices between employees. However, the precondition for a metaverse – or any new technology, for that matter – to become more common is that people are willing, not forced, to widely adopt such solutions in both their private lives and at work. This is why VTT has taken the human-driven approach for the industrial metaverse research.

The metaverse doesn't mean that everyone will work wearing smart glasses in the future. It is part of a much larger transformation of the next-generation internet that extends to organizational models and smart contracts. The possibilities of the metaverse should be looked at from three different levels: individual employees, teams, and organizations.

There are still many unresolved questions related to hybrid work in industry. Hybrid work has become common in office work, but how it could change hands-on industrial tasks and ways of working remains to be discovered. Some tasks may disappear, and new ways of working will emerge. To enable work in virtual and hybrid environments, there are still topics to solve related to physical and cognitive ergonomics. For example, what interaction tools are used, and how will they be available for workers? Novel technologies could support inclusiveness in workplaces. However, this can be a challenge, too. The technologies need to be designed and implemented to support workforce diversity, or they can create inequality among employees. Also, the systems will become more complex when the work is done in physical and virtual environments and within and between human-technology-AI teams. This can create challenges related to safety, security, and ethics. The change associated with the social aspects of work needs to be considered. It is essential that the workers feel part of the work community. In addition, the workers need to feel motivated and that their work is meaningful. In general, their work-life needs to be in balance. An overview of the topics to be investigated is presented in Picture 1.



Picture 1. An overview of research topics and themes.

The way forward is to co-design and develop highly economically scalable solutions applicable to all industrial segments. It is important to understand the needs of employees and create solutions that people can trust and want to use. The goal is to develop future industrial work tasks that people find attractive and provide benefits for companies regarding industrial productivity and well-being. Our research target is to improve flexibility, productivity, safety and multi-profession collaboration across organisations. To trigger a growth spiral in end user adoption and human-driven technology development, we need to address: 1. Desirability (wellbeing and willingness to use), 2. Viability (productivity and business benefits), 3. Responsibility (regulation and processes), and 4. Feasibility (technical maturity and economies of scale).

The next steps of the strategic R&I plans could be: 1. Setting the goal of Europe to be the forerunner of the industrial metaverse, bringing industrial companies to the era of Industry 5.0. 2. Creating a strategic research agenda that focuses on multidisciplinary development of metaverse initiative (human, technology, and business). 3. Preparing the needed R&D investments towards the shared goal.