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The Metaverse as Mediator between Technology, Trends, and the Digital Transformation of Society and Business

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Abstract

In this reflective article we discuss the potential of recent developments in virtual worlds for offering novel value propositions for the digital transformation of society and business. In particular, we consider the role of a Metaverse, understood as a globally accessible 3D virtual space and computing infrastructure—and today still a conceptual vision—as a mediator between technology trends and societal and business applications. We outline how current technology trends can be linked with high-value added application scenarios through the Metaverse as a mediating design space. Our insights project both a push effect, i.e. novel technologies fostering radical shifts in society and business, as well as a pull effect, i.e. radical ideas stimulating technology developments. Leveraging both effects for creating high-value added applications however, requires an integrated, mediating design space, which can potentially be obtained through advances of virtual worlds towards a Metaverse.

1. Introduction

What started out as visions of ubiquity (Weiser, 1993) of computing technologies and is now discussed under the umbrella term, Internet of Things (IoT), is undoubtedly linked to advances in virtual worlds' research. A term used particularly in the business domain, the IoT generally refers to networks of computing devices, such as sensors, software, and network infrastructure, which are embedded in physical objects, with the objective to enable connectivity for added value usage through business services. The at first sight rather intangible idea of the IoT, generating greater value and service by enabling data exchange between manufacturers, service providers and other connected devices ('things'), has recently been replaced by the broader, more tangible, concept of Cyber-Physical Systems (CPS) (Wolf, 2007; Lee, 2008).

The latter concept, CPS, accentuates a more intense linkage between computational and physical elements as well as *human actors*. As an analogy, the IoT serves as the technical subsystem to a variety of CPS as socio-technical systems. CPS promise to become a vehicle for generating unprecedented high-value added services; this expectation of a novel value proposition rests on the vision, (a) to embed ubiquitous technologies (aka ambient intelligence), into 'the real world', i.e., our physically perceived space, and (b) to embed human knowledge, cognition and intellectual performance seamlessly into a virtualized environment. What is required to tap this potential of value creation is a sustainable space that allows integrating technologies as well as human factors.

We see evidence for an increased proliferation of CPS within different domains, particularly supported by current technology trends that serve as domains of research and development (R&D) predominantly in information technologies (IT) (Gartner, 2015). These domains include the three streams of (1) advanced software applications such as cloud computing, (2) approaches to 'intelligence everywhere', involving advanced analytics approaches, and (3) mobile and virtual technologies supported by new input/output devices such as head-mounted display devices (see Figure 1). A key factor these domains have in common is the need for human actors to be integrated into the computational and eventually physical elements of the related systems, in order to generate value. Examination of the recent developments of these trends suggests a push effect, i.e., novel technologies fostering radical shifts in society and business, as can be seen for instance in the effects of cloud computing on businesses.

We believe that Virtual Worlds (VWs) can serve as platforms to facilitate the integration required by CPS. Recent R&D in VW applications, such as e-retailing (Bourlakis et al., 2009; Gadalla et al., 2013), or use of VWs for learning home (Han et al., 2010) or business simulations, serve as forays into developing such integration. Extrapolating from such examples, we conceive of a unified platform, the Metaverse, built on VW technologies that allow for the integration of technological, physical, and human elements of CPS (see also Davis et al., 2009; Dionisio et al., 2013).

2. Related Trends – IoT, CPS and the Metaverse

While the IoT represents a basic vision of an underlying infrastructure, applied research has turned towards CPS in order to support development of distinct solutions in various areas considered relevant for societal and economic progress such as industry, energy, mobility, health, and living (European Commission, 2015b). The potential impact of CPS has been estimated to bring about a "new industrial revolution" subsumed under the term Industry 4.0 (BMWi, 2015). Current large-scale R&D initiatives such as those of the European Commission (2015a) or the National Science Foundation (2015), acknowledge the significant challenges with respect to the creation of a base infrastructure that is able to accommodate solutions and services, on all involved technological and perception levels, i.e., including human design of CPS and their use, as well as on a global scale (Lee et al., 2015).

Realistic IT-based application scenarios of CPS lie in two major but overlapping domains – societal and business applications. An abundance of concepts that conceive of CPS for high-value impact in these two areas have been proposed. In the societal sphere, concepts such as smart grids, smart cities, smart traffic or smart home, or large-scale systems in the areas of health or disaster prevention, have been put forth (see Figure 1). Currently, various isolated solutions in each of these and other areas are under research as is the case, with respect to smart grids (Berger and Iniewski, 2012).

In the business sphere, concepts subsumed in the Industry 4.0 umbrella have been proposed to digitally transform current business operations. Current R&D on business models and operations, as well as organizational models such as virtual business networks and ecosystems (Chesbrough, 2009; Adner and Kapoor, 2010) for instance, reflect on the use of increasingly virtualized products and services under the term servitization.

The breadth and diversity of technological trends and potential applications spun by current efforts, advocate a unifying factor which can potentially serve as a singularity for the success of related developments. If we extrapolate R&D efforts to not only target isolated solutions to specific questions, but to also enable modular construction, adaption and linkage of services within several high-value application scenarios, a common ground is required for the design and implementation of the resulting CPS. As past research has suggested, this common ground involves human actors as both users and developers/designers of CPS (Lee et al., 2015). It will thus be imperative for the success of efforts that target a new foundation to the value creation through CPS, to provide for a unified design space for CPS. Using this space to implement new high-value added applications can potentially generate a pull effect, i.e. radical social or business ideas stimulating technology developments, because new value propositions can be realized.

This design space is required particularly in order to enable several indispensable characteristics in the potentially parallel processes of CPS design, deployment and use. Among them (a) the re-use of previous knowledge, (b) the agile and inventive combination of resources of different nature or by diverging providers, e.g., services, information and data, and (c) the dynamic adaption of (infra-) structural elements during the (re-) engineering of applications and services. These high level demands create various technological and methodical requirements for the design space, also with respect to its adoption and use (see Figure 1).

3. The Metaverse as Integrated Design Space

The Metaverse, previously imagined in fictional literature (Stephenson, 1992) has more recently been conceived as globally accessible and collectively used multidimensional (3D) virtual space and computing infrastructure, created by the convergence of virtually enhanced physical reality, and physically persistent virtual space (Metaverse Roadmap, 2007: Glossary). Various extrapolations have been made on technological, social, legal, economical and other aspects and factors to predict the evolution and success of Metaverse-related developments (Metaverse Roadmap, 2007: Foresight). In this context, recently ‘progress indicators’ have been defined such as social indicators (e.g., digital rights management policies, patent laws), business indicators (e.g., business models), or technological indicators (e.g., wearable technologies), which might help to evaluate the achieved progress (Metaverse Roadmap, 2007: Progress Indicators).

Instead of considering the Metaverse as purpose in itself, we want to consider it as a vehicle for shifts in cyber-physical evolution on various levels. In this vein, first attempts have been made to assure interoperability between existing virtual worlds (IEEE, 2015; ISO/IEC, 2015), or their accessibility (Krueger and Stineman, 2011). It is hence not surprising that standardization has been identified as major inhibitor or driver of developments for the Metaverse, as well as for technological trends and for CPS. Further drivers of development might prove relevant in the future, such as policies to prevent (consciously or unconsciously) unethical or unlawful action.

In our perspective, reaching the expectations related to CPS for high-value added application scenarios that sustainably answer and adapt to societal and business challenges - requires the creation of a unified design space. This space needs to integrate, moderate and adapt between various levels of technologies and human cognition. It will need to place humans into the loop of technological automation and adaptation, in an unprecedented way. We therefore conceptualize it as a mediator between technology trends and digital transformation in society and business. We believe that mediation can be achieved by representing ourselves as virtualized objects, through avatars, and immersive or assistive technologies. This might allow for improved human-centered collaborative and knowledge work within the virtual space, resulting in more effective knowledge utilization, system design and system integration.

Designing the design space, i.e., supporting a gradual evolution of the Metaverse, will require an iterative approach if the efficacies of development processes and services provided by the Metaverse, are to be evaluated. In this respect, design science research (Hevner et al., 2004) provides valuable guidance, by suggesting a feedback loop between empirically evaluating the performance of services in practice (the application scenarios; ‘push’), and pro-actively engineering new artefacts and services that might provide new value propositions (‘pull’). For creating an environment that is inclusive to a diverse set of stakeholders in CPS development and use, it will be mandatory to also define development and service platforms which will base on standardized technical blueprints and business revenue models.

An example for a business application scenario is the implementation of engineering workspaces in automotive braking. Braking systems in passenger cars, including components such as brake calipers, hydraulic unit, electronic unit, software, and multiple sensors, can be conceived as cyber-physical systems (CPS) that, from business perspective, undergo shortening innovation cycles. The life cycle of these systems, including engineering, production and use, can be virtualized by integrating sensor data collected during use and production monitoring, and by feeding this information back into the engineering process. This way, an integrated CPS as embedded, real-time system, addressing cognitive safety for passenger vehicles can be obtained.

In this example, the Metaverse can be perceived to aggregate services from the various information systems, representing engineering expert roles, production sites of braking components, and real-life usage. It can thus provide an integrated view on stakeholders, their roles, knowledge service contributions, collaborative processes and tasks, as well as human perceptions, expertise and information needs. In order to implement this vision approaches enabling a model-based configuration of the involved braking system developers’ individual workspaces are required. Models that represent the engineers’ knowledge can support their team collaboration by linking their respective systems ad hoc within integrated software architecture. This way, engineers can become part of an adaptive design space, and leverage their individual expertise by self-configuring their own workspaces in dialogue with their peer team members.

4. Conclusion

Over the past decade, we have seen technological developments that enable the blending of the physical and the virtual. Augmenting reality with layers of information from the virtual world is now enabled in various ways for a myriad of applications – from personal entertainment to enterprise projects. By extrapolating from technological trends we envisage the need for a mediator, the Metaverse, which serves as a unifying platform and design space for high-value added applications. In this article, we provide a conceptualization for such a design space. We believe that the Metaverse offers a prominent opportunity to use human-centered approaches for creating high-value-added applications in a new generation of Cyber-Physical Systems.

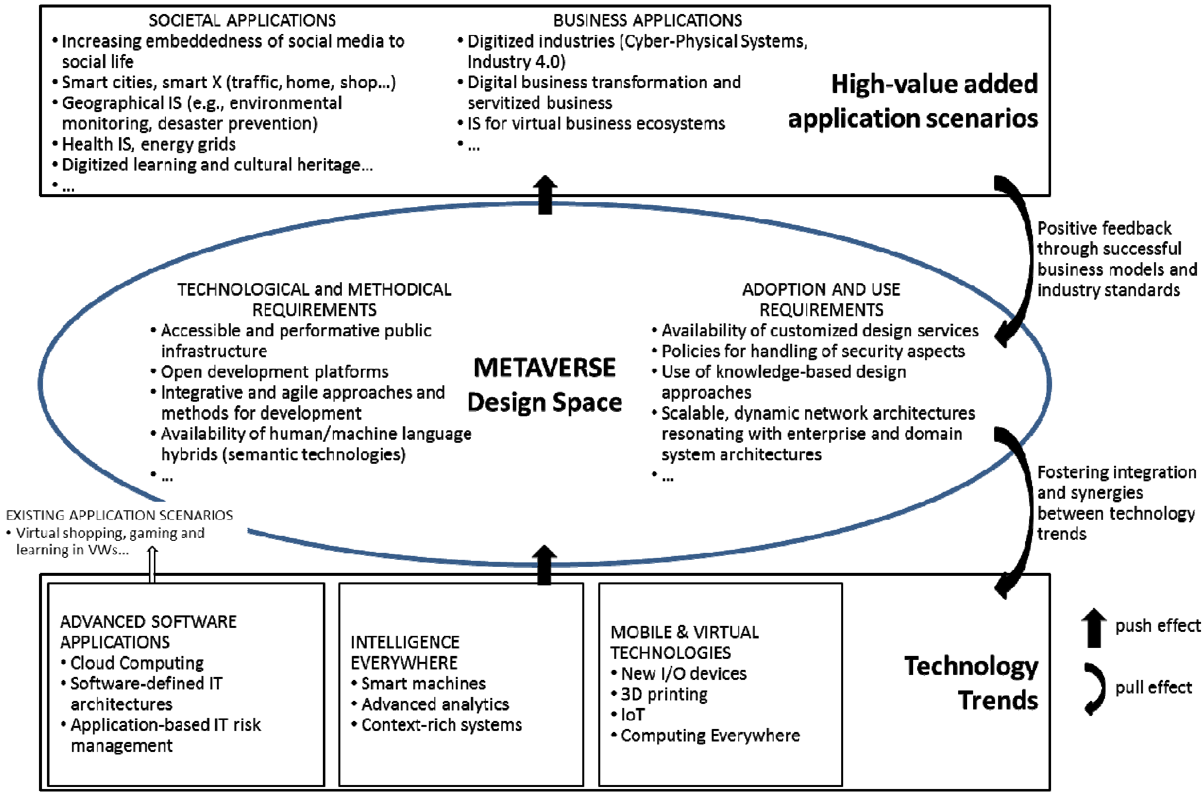

Figure 1: The Metaverse as mediating design space between technology trends and high-value added application scenarios in society and business.

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