Digitally Cloning the Physical

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The developments of Digital Twin-based solutions is receiving increasing attention from a large community of developers. The concept of the Digital Twin is not anymore confined into the realm of manufacturing. Lots of applications are adopting the approach in different application domains such as smart cities, e-health, logistics, education, and many more. The Digital Twin is a software representation of a corresponding complex physical object. The digital twin is based on two important features that are of the interest for the software and Information Technology community: data and modeling. Data are the central aspect for monitoring and representing the status of a physical object. Having access to well-formed data makes it possible to represent the salient features and characteristics of the physical object. The second major feature is how these data are to be organized and processed in order to reflect the actual status of the physical object.

Data management and modeling are steps in any Digital Twin solution is to ensure that there are good quality data and the model used to organize them is actually reflecting the reality of the working of the physical object. However, they are just two major facets of many other properties of the Digital Twin representation. In fact, from an IT perspective, the way data are collected, curated, and organized represents relevant challenges. Dealing with large data sets immediately introduces the possibility of applying Artificial Intelligence technique in order to predict the behavior of the physical object or for understanding its expected working and properly manage it. The flow of data from the physical object and the functions processing them is clearly another interesting matter for IT Professionals, i.e., how to guarantee that these data are collected and made available in due time and with the expected frequency. Other relevant issues in Digital Twin-based solutions are related to the abstraction and contextualization of the information with respect to the needed modeling. In other terms, the model should be as simple as possible, because it requires extensive processing and resources, but it should not be simplistic. In many applications, the exceptions in the behavior of the physical object in extreme conditions are important in order to limit the testing of the physical object and for predicting its reaction in stressful conditions. The prediction of the behavior of the physical object is directly leading to simulations and prediction. The Digital Twin is in fact a valuable tool for simulating the behavior of an object in the future under critical conditions. The simulation capability can be useful in order to carry out preventive management on many IT related systems.

Digital Twin also points to a relevant issue related to data ownership and privacy. The owner of the physical object is not necessarily the owner of the Digital Twins. In fact, there may be different replicas of the DT in different domains. The issues related to which data to share, who owns them, how to share are immediately recognizable. In addition, the description of the behavior of the DT can be easily related to the usage of the physical object made by its owner and, hence, it may be possible to derive the behavior of the user. The DT requires a consolidation of data ownership and privacy best practices in order to guarantee security and privacy of many actors involved. Digital Twins will also be implemented as large, and sometimes complex, distributed applications. Their deployment and execution need to guarantee some expected Level of Services that the computing infrastructure should guarantee. The Digital Twin is expected to use distributed and tiny AI, to extensively make use of edge computing for rapid processing of some data and prompt execution (e.g., actuation) of local actions. The Digital Twin sits on top of many of the most recent developments and advances of IT systems.

All of the above advocate that Digital Twins will be a key feature in the next generation of internet-enabled ecosystem (Metaverse is claiming to be it), shaping a new digital economy, where the role and potential of end users will be upgraded. In this context, this issue of *IT Professional* hosts four articles on views and ideas for the emerging hybrid world, focusing on Digital Twins and linking them with Metaverse.

The first article on this list, "VCFN: Virtual Cloth Fitting Try-On Network," by Muhammad Usman Ghani Khan et al. is on the way virtual world concepts can help in physical world tasks and habits, by presenting a virtual cloth fitting network, thus addressing a concept that presents an increasing demand with a growing online shopping trend. The second article, "Virtual Dimension—A Primer to Metaverse," by Hijab E. Zainab et al. goes one step beyond the blending of physical and virtual worlds, and presents a brief overview of technologies used in the development of metaverse: the challenges and the potential aspects of the virtual world. The third paper, "Building Digital Twins of Cyber Physical Systems With Metaverse for Industry 5.0 and Beyond," by Senthil Kumar Jagatheesaperumal and Mohamed Rahouti proceeds in this direction and shows how to link Metaverse with the Digital Twins. Along this course, it presents a service-oriented Digital Twin architecture in conjunction with metaverse-enabled platforms with recommendations for interactions with the CPS for Industry 5.0 scenarios and beyond. The last of the four papers, "Collaboration of Digital Twins Through Linked Open Data: Architecture With FIWARE as Enabling Technology," by Javier Conde et al. focuses on the communication and collaboration of the Digital Twins and proposes the use of Linked Open Data as a mechanism to facilitate the communication of Digital Twins, presenting a use case of an urban Digital Twin that collaborates with a parking Digital Twin.

We think these papers cover a vast area of topics embracing Digital Twins, data management, and modeling of virtual worlds that could be of interest for IT professionals.

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