Federal Register Notice: 89 FR 51554, Federal Register :: Networking and Information Technology Research and Development Request for Information on Digital Twins Research and Development, June 18, 2024.

Request for Information on the National Digital Twins R&D Strategic Plan

Ala Moradian

Statements here solely represent the views of the responder and does not reflect perspectives of his employer.

Digital twins are founded based on models, domain knowledge, software, compute, and data infrastructure, as well as sensors and metrology.

The twin would need to be characterized along dimensions such as type of models that re being used, fidelity of the models, connectivity and synchronization, value proposition, as well as type and nature of interaction with the user.

- ***Artificial Intelligence (AI):*** Hybrid twins founded on both physics and data models will be a critical approach in addressing challenging industry problems across domain. The data models include all type of machine learning models such as graph neural nets, physics-informed neural nets (PINN). Other topics could include, AI for system identification and reduce order model development, AI-assisted sensor data screening and clean-up, optimizing approach needed depending on the nature of system and continuous re-training of twins.
    - *"Semiconductor Equipment and Processes Need Digital Twins," 23 Jul. 2023. [Online]. Available: https://www.appliedmaterials.com/us/en/blog/blog-posts/semiconductor-equipment-and-processes-need-digital-twins.html.*
- ***International:*** Opportunities for international collaboration and connecting the focused investments such as Chips for America, i.e., ChipsACT with other international initiatives such as projects funded by European Union like interTwin, TwinGoals, NeuroTwin, Change2Twin, European Union's Horizon
    - *U.S. Department Of Commerce, , "CHIPS for America Announces $285 million Funding Opportunity for a Digital Twin and Semiconductor CHIPS Manufacturing USA Institute," "U.S. Department Of Commerce", 6 May 2024. [Online]. Available: https://www.commerce.gov/news/press-releases/2024/05/chips-america-announces-285-million-funding-opportunity-digital-twin.*
    - *interTwin Project, "interTwin," 2023. [Online]. Available: https://www.intertwin.eu/about-intertwin/.*
    - *TwinGoals, "EIT Manufacturing and 'Digital Twins' improving tomorrow's manufacturing," 28 Oct. 2020. [Online]. Available: https://eit.europa.eu/news-events/news/eit-manufacturing-and-digital-twins-improving-tomorrows-manufacturing.*
    - *NeuroTwin Project Website, "https://www.neurotwin.eu/," 2023. [Online]. Available: https://www.neurotwin.eu/. [Accessed 10 Nov. 2023].*
    - *Change2Twin Project, "Change2Twin - Digital Twin for every manufacturing SME!," 2020. [Online]. Available: https://www.change2twin.eu/.*
- ***Long Term:*** Considering that data would construct the basis of digital twins either for their development or validation, verification, uncertainty quantification, long term investment in improving sensors technology remain critical. Computational hardware advancement fit for use for specific type of twins, hybrid hardware structures, for example, taking advantage of CPU and GPU in a dynamic sense, could be another strategic area to be investigated.

- ***Sustainability:*** digital twins for sustainability optimized operations of manufacturing facilities, entities and tools, e.g., EcoTwin to monitor, improve, and optimize consumptions and operational adjustment, and asset scheduling
    - *Applied Materials inc., "EcoTwin™ Eco-Efficiency Software," 9 Jul. 2023. [Online]. Available: https://www.appliedmaterials.com/us/en/semiconductor/solutions-and-software/ai-x/ecotwin.html.*
    - *SEMICON West, Smart Manufacturing: EcoTwin - An Integrated Solution for Sustainability in Semiconductor Manufacturing, San Francisco, CA, 2023.*
    - *United States Patents US20220334569A1, US20230185268A1, 2021.*
- ***Workforce:*** Use of digital twins to train talents for strategic and national interest like semiconductor manufacturing by developing virtual platforms developed based on actual trends and know-how, e.g., EduTwin™, SemiGuru™
    - *M. da Silva and K. Somani, "Digital Twins in Semiconductor Manufacturing - SEMI Smart Manufacturing Initiative," SEMI, San Jose, CA, 2024.*
    - *Book Chapter: Digital Twins for Sustainable Semiconductor Manufacturing, Volume: Digital Twins, Simulation, and Metaverse, Book Series: Simulation Foundations, Methods and Applications, Editors: Michael Grieves, Edward Hua, Springer, In press (Nov 2024).*

Ala Moradian, Ph.D., P.Eng., ASME Fellow

Biography: Ala Moradian is a director at the Computational Product and Solutions (CPS) Center of Excellence at Applied Materials where he is focused on epitaxy technology and digital twins for semiconductor manufacturing. Over more than a decade at Applied, Ala has worked on different products and business units such as ion implant, rapid-thermal processing, epitaxy, physics-based simulation and led the development of several new technologies and products. His roles included CFD expert, heat transfer subject matter expert, scientist/physicist, program lead and product manager. He is also the intellectual property technologist for Epitaxy business unit at Applied Materials. Ala obtained his PhD in mechanical engineering from University of Toronto, a master's from Sharif University of technology, and a Masters in management from Harvard University. Ala is a Fellow of American Society of Mechanical Engineers (ASME), and an adjunct faculty at UC Berkeley. He has over 20 publications and over8 US patents and applications. Ala have served on NSF SBIR/STTR for the last decade.