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

Charalampos Markakis

DISCLAIMER: Please note that the RFI public responses received and posted do not represent the views or opinions of the U.S. Government. We bear no responsibility for the accuracy, legality, or content of the responses and external links included in this document.

Via FDMS

Charalampos Markakis, 7/28/2024

[redacted]

Subject: RFI Response: Digital Twins R&D Plan Attention: Melissa Cornelius, [redacted]. Include a phone number for reference: [redacted] Approval Statement: This document is approved for public dissemination. The document contains no business-proprietary or confidential information. Document contents may be reused by the government in the National Digital Twins R&D Strategic Plan and associated documents without attribution. [redacted]. Include a phone number for reference: [redacted]. Dear Fast-Track Action Committee, Thank you for the opportunity to provide input on the National Digital Twins Research and Development (R&D) Strategic Plan. I am a scientist and university professor supervising transdisciplinary teams working on supercomputing applications. I would like to suggest expanding the definition of digital twins to encompass their diverse applications across important strategic areas in computational fields. This will ensure a comprehensive and effective strategy for digital twins research and development. Definition of Digital Twins in computational sciences To effectively guide R&D priorities of federal agencies, it is important that the definitions of digital twins encompass their diverse applications across various fields. In particular, it is important to include the concepts of numerical modelling, numerical simulation, and development of numerical algorithms, in various fields. For example: Computational fluid dynamics, numerical mathematics and computational physics: Digital twins can involve numerical simulations solving the hydrodynamic or magnetohydrodynamic equations numerically to model fluid flow. Numerical simulations in fluid dynamics are essential for studying complex flow phenomena across various scales, from atmospheric flows and turbulence modelling, to neutron stars and black hole accretion rings. These simulations of the digital twins can help increase our understanding of their physical counterparts, to detect such systems and estimate their physical parameters from observations, and predict their behaviors. For example, this can include: -Computational atmospherical sciences: simulation and prediction of hurricanes and weather forecasting -Computational astrophysics: simulation of binary black holes or neutron stars, and their gravitational wave extraction from simulations, used for their eventual observation by detectors such as LIGO or LISA. -Shock formation in hydrodynamic and other partial differential equations The above methods can be enhanced with AI (i.e. with numerical simulations used to calibrate AI algorithms, or AI algorithms used to complement and improve numerical methods). Computational finance, forecasting and risk modeling: Digital twins, enhanced by AI and advanced metrics like Value-at-Risk (cVaR) or Conditional Value-at-Risk (cVaR), offer significant improvements in managing market risk - the risk of losses due to extreme market price fluctuations, which can impact the wider economy. We might propose a focus on two areas: Market Scenario Simulation - Implement digital twins to simulate market conditions and their reaction to extreme scenarios - Leverage AI to enhance simulation accuracy, learning from historical data - Capture tail risks and extreme market movements underestimated by traditional models Advanced Risk Metrics - Use digital twins for dynamic VaR assessments based on real-time data, and incorporate cVaR to estimate potential extreme losses - Employ AI to refine these models by analyzing large datasets

and identifying subtle risk factors Such approaches would provide a better assessment of credit and market risks, allowing financial and government bodies to better anticipate or mitigate them. This line of research can use AI to build upon established methods of improving risk management through advanced computational techniques and robust statistical models. This can help predict and minimize "fat tail" risk (i.e. black swan events) and make the US economy stronger and more robust in the event of extreme (black swan) phenomena, such as pandemic outbreaks, wars, and other financial shocks. The National Digital Twins R&D Strategic Plan can maximize its impact by encompassing transdisciplinary computational topics. This approach will drive innovation, improve predictions, and enhance decision-making across domains. By integrating AI with numerical methods and investing in cross-disciplinary research, we can advance science, strengthen technological leadership, and transform complex system management. Strategic investment in digital twins will yield both scientific progress and practical societal benefits.