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

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According to Committee's definition builds on a definition from an AIAA and AIA Position Paper (2020), Digital Twin (DT) is defined as "a set of virtual information constructs that mimics the structure, context, and behavior of a natural, engineered, or social system (or system-of-systems), is dynamically updated with data from its physical twin, has a predictive capability, and informs decisions that realize value".

Policies on Digital twins must cover the three types of Digital twins: *Digital Twin Prototype* (DTP), *Digital Twin Instance* (DTI), and *Digital Twin Aggregate* (DTA). The policies will include process formulation, sensors integration, product delivery and product testing and maintenance/sustainability just to mention but a few. And the use of different technologies such as, Internet of Things (IoT), Big Data, 3D Visualization, etc. will come to play.
A Digital Twins should be Fit for Purpose system that is complete and that can deliver.

Therefore, policies on Digital Twins (DT) technology for each application must address the following challenges: Data Availability (e.g. Accuracy and currency, …), Complexity (e.g. personnel, technology, and software), Security (e.g. data from many sources), Integration (e.g. systems and practices), and Accuracy (data and models). All these can affect simulation accuracy and performance. This will also involve various experts/professionals, technologies, environment and rules.
For each field and application, the policy must cover these areas of Digital Twins (DT):

1. **Data-** Generally, before collecting data for DT one must consider: (i) data identification, (ii) data verification, (iii) data unification, and (iv) data enrichment. All these will come to play in:
    a. Data Collection: specific data collection must ensure, accuracy and precision, completeness, reliability, validity, accessibility, action research, detailed (data sets contain all necessary information), observation and timeliness
    b. Data Quality: this will include, completeness, accuracy, timeliness, validity, consistency, uniqueness, integrity, data governance, precision, relevance, reliability, accessibility, data quality management, data validation, data profiling, clinical data management, data quality dimensions, understandability, appropriate amount of data, comparability, compliance, conformity, data cleansing, and data granularity and relevance.
    c. Data Security: data security has many characteristics, including: encryption, data masking, access control, authentication, data erasure, data resiliency, compliance. data security must ensure, confidentiality, integrity (authenticity) and availability.
    d. Data Interoperability: this has to do with, syntactic and semantic, (technical), and cross-domain or cross-organization (legal).
    e. Data Transfer/Migration: this will include, accuracy, precision, speed, timeliness, reliability, bandwidth, error detection, data compression and data encoding.
    f. Data Management: Data management involves collecting, storing, organizing, maintaining and analyzing data to assist decision-makers. Data management characteristics include: data security, data quality, data governance, data redundancy, data backups and data integrity. A good data management techniques should be able to: improved data quality, increased data security, lower costs, better decision making, faster access to information and improved productivity.

       Crowdsourced or multi-sectoral data sources and enforcing multi-level security approach may reduce both cost and cybersecurity challenges. Pulling resources together for similar businesses e.g. SMEs that are geographically located or through IoT for distant ones can reduce cost.

2. **Modelling-** This will include policies on, user requirements survey, conceptual design, logical design, physical design, and implementation. The modelling will assist in operation, predicting, prescription, and visualization.

3. Linking- Policies on how the digital twin results can be escalated to enhance improvements and developments must be put in place.

With the Digital Twin (DT) technology, accuracy of geospatial applications (virtual maps) can be improved through:

1. Real-time data capture- to update geospatial simulated systems
2. Data analysis and visualization- to assist in analyzing data content, completeness, accuracy, quality, etc. and simulate the system for a real-time 3D visualization
3. Collaboration and communication- to assist in joint collaboration between the different stakeholders including users and provide a seamless data and information flow or transfer among the stakeholders for efficiency and accuracy, and
4. Decision-making and risk management- to assist in making informed decisions and access risk(s) involved and how to share the risk.

Policies on virtual maps must cover, creating digital models (maps), computer algorithms, techniques, data from different sources, different software and hardware and standards, data processing and analyses, and visualization to simulate physical world entities and assess various designs and planning options.

Policies on several application areas of Geospatial Digital Twins include:

- Energy Applications policies e.g. Wind energy, Solar energy, etc.
    - Wind energy- Geospatial Digital Twins application that will mimic (simulate) the direction of the flow of wind to attain maximum wind efficiency
    - Solar energy- Geospatial Digital Twins application that simulate and determine the best location for obtaining maximum energy radiation from the sun.
- Transportation policies e.g. traffic simulation, proposed road modelling, etc.
    - Traffic simulation and Traffic monitoring- The policies must cover a real-time data collection and streaming from traffic sensors (cameras) on the roads to the server

in the control room to simulate and update traffic data that will assist traffic managers in decision making.

    - 3D Modelling and Visualization of Proposed Roads- A proposed road can be modelled in 3D and visualized to see how it is going to perform after construction. Different components/parts of the road can be simulated and tested e.g. road alignment, drainage type, volume of traffic, turnings on the road, etc.

- Soil test policies- For a multi-storey building, a prototype soil (texture and strength) and building simulations can be created that will test how long a building can last under different weights attached.
- Architecture, Engineering & Construction (AEC) policies- A complete engineering project can be simulated in the Geospatial Information Science (GIS) environment to test every component of a proposed building or factory. *Building Information Modelling (BIM),* will also be an advantage here.

Geospatial Digital Twin applications' policies shall cover these areas so that there will be efficiency, accuracy, trust and product delivery.