

Intro to Digital Twin

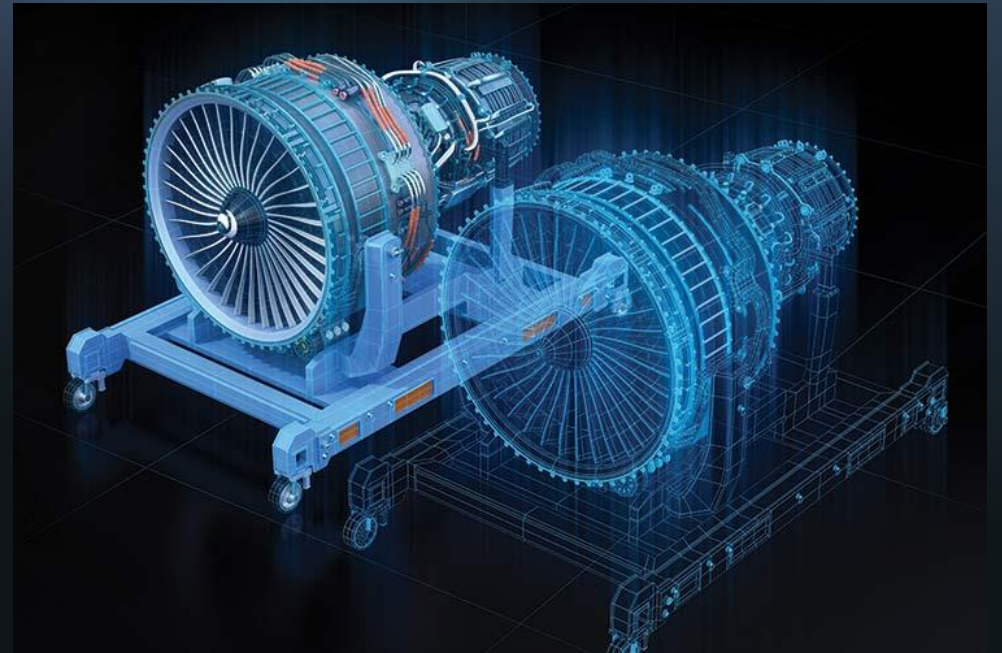
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Definition of Digital Twin

- Virtual representation of a physical object or system
- Real-time monitoring
- Data transfer
- Analysis
- Simulation

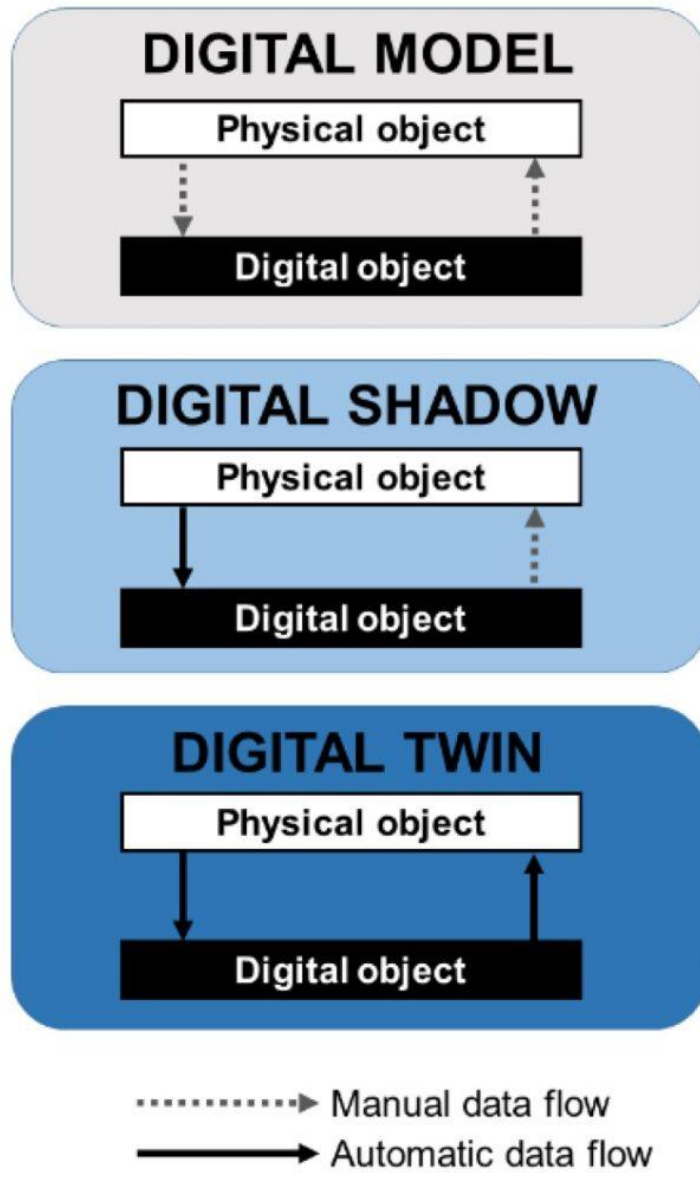


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Digital Twin Categorization

- Pasive Digital Twin
 - Monitoring
 - Mirroring
 - Historical data storage
 - UC
 - Performance tracking
 - Structural monitoring
 - Historic model for decision making
- Active Digital Twin
 - Feedback to physical twin
 - Control of physical twin
 - Simulation
 - Predictive
 - UC
 - Autonomous systems

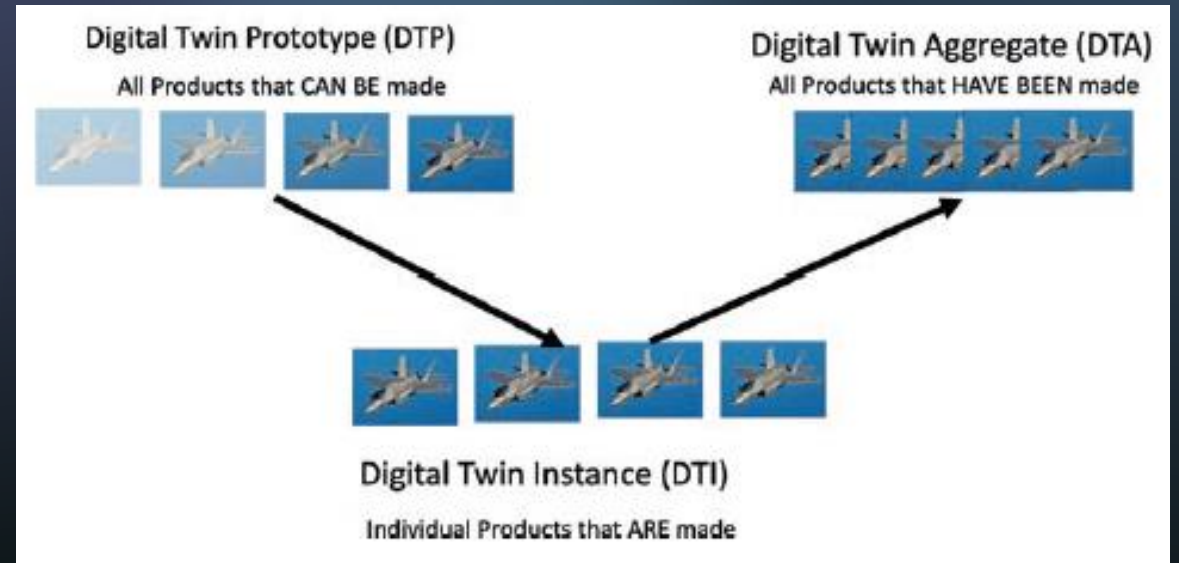
Digital Twin Categorization



- Digital model
 - Manual data flow between physical and digital twin
- Digital shadow
 - Automatic data flow from physical to digital twin
 - Manual data flow from digital to physical twin
- Digital twin
 - Automatic dataflow between physical and digital twin

Digital Twin Types

- Digital Twin Prototype
 - Test model before implementation
- Digital Twin Instance
 - Unique object or system, connected to physical world
- Digital Twin Aggregate
 - Collection of multiple digital twins creating a larger system



Technology used in Digital Twin

- IoT - Collect real-time data of physical object or system
- Cloud Computing - Scalable way of procesing aquired data
- Big Data Analytics - Analysis of aquired data
- Database - Data storage
- AI and ML - Predictive analysis, pattern recognition, decision making
- Visualization Technologies - Digital visualization of physical object or system
- Cybersecurity - Protection of Digital Twin
- Communication Technologies - Transfer of data

Challenges and Concerns in Digital Twin

- Complexity
 - Components
 - Scope
 - Fidelity
- Dynamism
 - Frequency
 - Interaction
 - Impact
- Security
 - Data privacy
 - Data security
 - Access control
- Integration complexity
- Implementation cost
 - Initial cost
 - Running cost

Future of Digital Twin

PAST TO PRESENT

- Term Digital twin used in early 2000s
- Aerospace, manufacturing
- Industry 4.0, IoT brought boom for DT technology
- Implementation of AI to DT

PRESENT TO FUTURE

- Increase of use in different fields
- Challenges for future
 - Integration with IoT, AI
 - Advanced simulations
 - Data management
 - Data transfer

Use of Digital Twin

- Aden, China
 - Digital twin created for facility service management
 - Better energy consumption
- Car manufacturer, Europe
 - Digital twin created for simulating crash test of cars
 - Eliminated need for physical prototypes by 70-100%
 - Ability to predict critical areas of new models
- The Framingham, USA
 - Digital twin created for remote manufacturing
 - Doubled the medicine production
 - Reduction in energy consumption and pollution

Sources

- Crespi, Noel, Adam T. Drobot, and Roberto Minerva. The Digital Twin. Cham: Springer International Publishing, 2023.
- Vohra, Manisha. Digital Twin Technology: Fundamentals and Applications (2022)
- Singh, Maulshree, et al. "Digital twin: Origin to future." Applied System Innovation 4.2 (2021): 36.
- Jones, David, et al. "Characterising the Digital Twin: A systematic literature review." CIRP journal of manufacturing science and technology 29 (2020): 36-52.
- <https://www.analogictips.com/whats-a-digital-shadow-and-how-does-it-relate-to-a-digital-twin-faq/>