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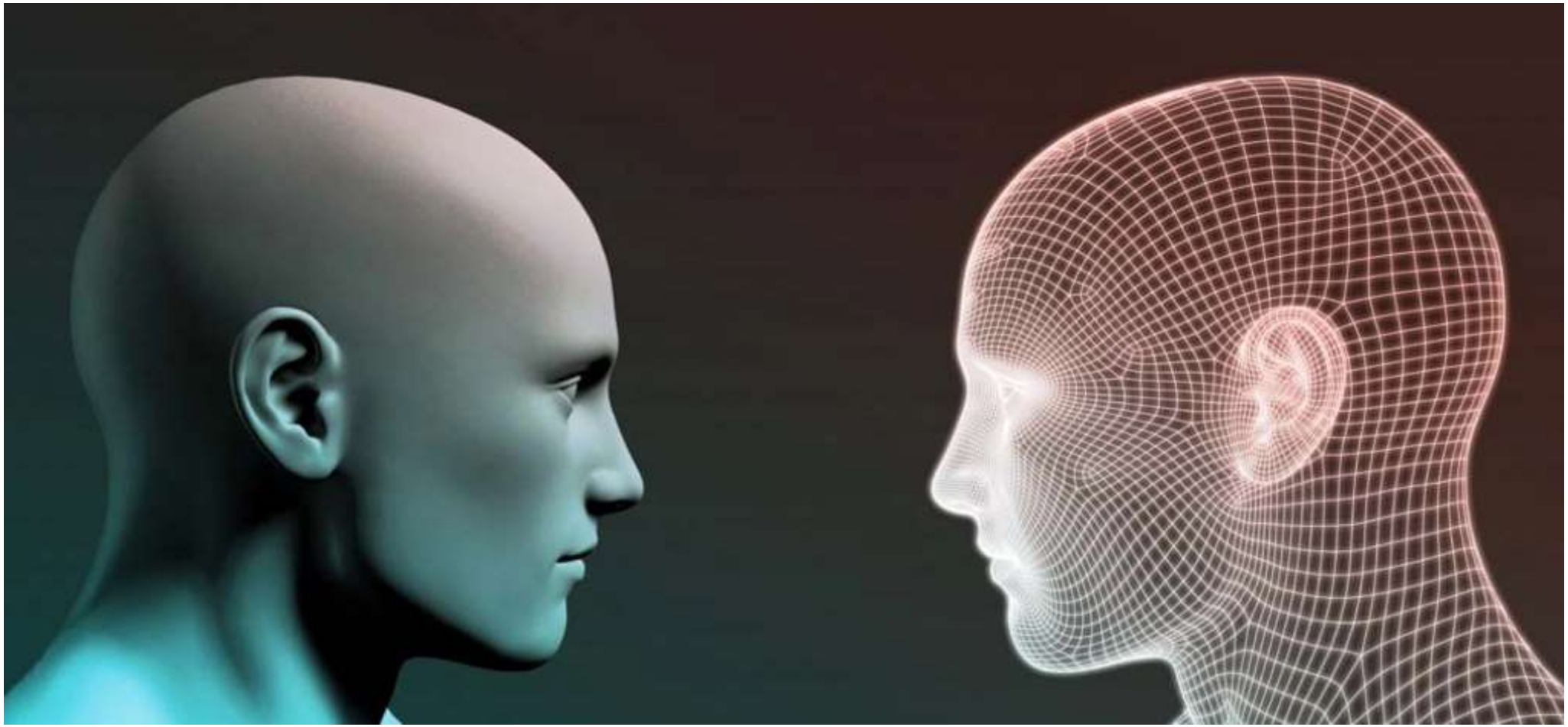

# Metaverse Digital Twin

Digital Twin Technology – Possibilities and Applications

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# What is Digital Twin Technology?

A digital twin is a virtual representation of an object or system to create an exact digital counterpart, using real-time data along with AI-ML to simulate multiple possibilities that enriches the decision-making process

**The physical systems are interconnected with the digital twin forming a closed loop, called a *'Digital Thread'***




**This integration of data in real world and virtual representations helps in optimizing the performance of real assets**

## The tech could be classified under three broad categories

### Digital Twin Prototype (DTP)

This uses digital twin to design and create **virtual prototypes**, which contain information on assets' physical attributes, properties, and operating parameters

### Digital Twin Instance (DTI)

Digital twin can be used to run tests on different **usage scenarios of an asset** that helps predict an asset's behavior under different circumstances

### Digital Twin Aggregate (DTA)

A DTA is an aggregate of multiple DTIs from different assets. The DTIs may be co-located within one entity or across entities. **DTA examines asset behavior on a group level** revealing unknown and unexpected insights linked with an asset's environment

# Importance of Digital Twin

Digital twins have helped asset-intensive industries overcome challenges in managing an increasing number of complex assets by creating virtual models of the end-to-end process, enabling nimble operations

## Digital twin Vs CAD simulations

- **Scope of use** –
  - A CAD[1] simulation typically looks only at a particular aspect, e.g., design
  - A digital twin crafts a virtual environment to run several simulations simultaneously to look at multiple aspects, e.g., all stages of a product life cycle
- **Data interactions** –
  - CAD simulations are limited to parameters introduced by the designer
  - Digital twins, on the other hand, use parameters updated with the real-time data into their computing models to run richer simulations

## Benefits of digital twin

- **Improved R&D** – A digital twin allows a manufacturer to test a product without the standard physical testing of a prototype. It can simulate the conditions for a product more quickly and efficiently, saving time and cost
- **Greater efficiency –** Digital twins can mirror and virtually predict the state of a system in a physical world and hence help maintain peak efficiency throughout a manufacturing or production process
- **Unparalleled learning platform –** Digital twins provide excellent training and development platforms by using virtual representations of products and processes to deliver an immersive learning experience

## Digital twin – Recent Developments

**NASA** built a helicopter fit to survive on Mars by first creating a digital twin of Mars and a digital prototype of the helicopter with all the inputs and environments required. It tested, changed, adapted the digital prototype to Mars's digital twin using virtual systems to make relevant modifications which were then used to develop a real-world Mars helicopter

**Siemens** is designing and building a digital twin of Singapore's Downtown Line's (DTL) signaling system. The simulation center will enable in-depth and faster technical analysis surrounding signaling-related incidents, enhance testing of new signaling features and system functionalities before deployment as well as increase capabilities for training land transport authority and the operator's technical staff

**Fujitsu** is focusing on development of 'social digital twin tech' in smart cities to create foundational technologies for social digital twins that will simulate traffic networks and movement patterns of people in real time to ease congestion, positively influence travel behavior and help build more sustainable and safe cities

1. Computer-aided design

# Digital Twin Applications in Industries (1/3)

Digital twin helps aerospace and automobile companies in predictive maintenance, vehicle tracking, design verification and condition monitoring

## Aerospace

### Predictive maintenance

A digital twin of an aircraft can predict engine failures based on previously accumulated data and enable engineers to investigate the potential problem. This also helps in predicting when a part is reaching the end of its lifespan

### Transform workflow

By creating digital twins of their workflow processes, aircraft manufacturers can discover ways to improve staff productivity, minimize nonproductive time and avoid budget-busting interruptions in production

### Aircraft tracking

With a digital twin, businesses can track the performance of their aircrafts with ~150% more accuracy for longer distances to craft flawless blueprints and roadmaps

### Optimize load

A digital twin provides full transparency on the components of an aircraft, allowing engineers to see which parts are under weight strain and determine the exact weight of an aircraft in real-time

## Automobile

### Data management

Using virtual simulation, businesses can analyze data in real time and plan uninterrupted production, thus minimizing financial loss. Integrated data can also provide insights into performance, driver behavior

### Predicting demands

Using digital twins, manufacturers can collect and leverage customer experience data, such as which features are most used by customers, in order to better predict the future needs and demands of their customers.

### Design verification

Digital twins can speed up the design process by providing a quick and reliable way of verifying design efficiency and viability by sourcing the data required, running simulations and providing accurate results

### Monitoring condition

Throughout the lifespan of a car, digital twin can monitor the health of parts, processes, and activities that occur inside an engine and provide updates on the well-being of the vehicle

## Recent Developments

GE Aviation

### Built first digital twin for aircraft landing gear

GE built digital twin components for its GE60 Engine family and developed the world's first digital twin for an aircraft's landing gear. The components collect data from sensors placed on typical landing gear failure points, such as hydraulic pressure and brake temperature, to predict early malfunctions or assess the remaining life of the landing gear

TESLA

### Digital twin on wheels

Tesla Motors delivers better service and reliability to car owners by creating a digital twin of every car it sells. The company updates software on individual vehicles based on their collected sensor data. This data-driven process enables an efficient resource allocation and a better user experience

# Digital Twin Applications in Industries (2/3)

Healthcare benefits from the exhaustive repository of information and personal touch provided by a digital twin | Retail can use it to establish better supply chains and perform quicker product risk assessments

## Healthcare

### Improved R&D

By creating digital twins of drugs and chemicals, one can modify them to improve their therapeutic efficiency. Similarly digital twins of devices can be tested, and design alterations can be made virtually before manufacturing thus reducing costs of failures

### Optimize healthcare

A virtualized hospital can be used to test the impact of various decisions on the organization's performance. Different modifications related to operations and supply chain can be tested virtually, thus eliminating the need of a pilot run

### Personalized medicine

A patient's digital twin can help customize a treatment based on their unique genetic makeup and anatomy. It can also provide the caregivers with a comprehensive view of their medical history providing better insights and clinical decision-making abilities

## Retail

### Steadier supply chains

Retailers can combine their digital twin models with external real-time data such as weather and traffic, allowing them to respond to any kind of event that may disrupt their supply chain

### Rapid risk assessment

Digital twins allow companies to test products prior to launch which helps identify any process defects before the product proceeds into production, improving risk assessment

### Increased Productivity

Digital twins facilitate efficient customer services by offering personnel with constant access to customer information on preferences. It also helps in ironing out the unnecessary product characteristics to focus on developing in-demand offerings, thus considerably improving the operational efficiency and productivity

## Recent Developments

GE Healthcare Command Centers

### Driving efficiency

The GE Healthcare Command Center is an initiative towards virtualizing hospitals and testing the impact of operational decisions on changes in overall organizational performance

SIEMENS

### Virtual production lines

Siemens uses digital twin with several vaccine manufacturers to design and test multiple vaccine production line configurations, which accelerated products launch from 1 year to 5 months

Kroger

### Keeping it fresh with digital twins

To improve product freshness and optimize logistics, Kroger is constructing digital twins that reflect meat cutting schedules, and physical product layouts. The goal is to ensure that the process lines are short and smooth, and the warehouses are well organized so that the meat cuts are always fresh

# Digital Twin Applications in Industries (3/3)

Digital twins can help remove irregularities in the manufacturing process and provide new revenue options | Energy sector can benefit from the more efficient energy production and asset management

## Manufacturing

### Personalized product

Digital twin plays various roles within the product lifecycle. With the growing demands of individualized products, it can provide an effective solution for future product design, development and innovation

### Reduce costs

Digital Twins can reduce the costs in the manufacturing industry, minimizing unexpected downtime. By predicting possible failures, companies can repair defects at their earliest, reducing costs

### New revenue streams

Digital twins can help manufacturers design new products and improve existing ones at a fraction of the current costs by eliminating the need for building physical prototypes and performing expensive modifications. Digital products and data analytics on these products can be offered as a service in the metaverse

## Energy

### Strategic planning

Digital twins can be leveraged to explore the effects of different policies, strategies and plans related to the optimal network structure (location, size, end users and infrastructures) of an energy system

### Microgrid management

Incorporating a digital twin at microgrids can allow designers and operators to simulate the impacts of cost-cutting and help provide optimal servicing to multiple customers

### Risk management

It is vital to adequately quantify the risks associated with the adoption of renewable and low carbon energy technologies. Digital twins can play a vital role in supporting the prevention of errors during initial implementations and be used to certify levels of safety or resilience for new methods, services, and features and extend the life of high value assets

## Recent Developments

BOSCH

### Digital building twins

Bosch's digital twins provides a new view of the buildings. Historical information along with comprehensive data captured in real time is applied to create a precise image of the facility that is constantly updated and refined

SIEMENS

### Reducing risk and cost with digital twin tech

Siemens built a fully functional digital twin of a whole train, including a functional simulation of all the wiring

agder energi

Microsoft

### Digital twins for performance optimization

Agder Energi, a Norwegian electric utility, is using Microsoft Azure Digital Twins to identify ways to operate its electrical grid more efficiently through distributed energy resources, device controls, and predictive forecasting—thus avoiding costly and time-consuming network reinforcement and infrastructure upgrades

# Challenges in Implementation of Digital Twin

Although the benefits of digital twins are immeasurable, achieving mass adoption is still a challenging task as the emerging technology must overcome various obstacles to unleash its underlying potential

## INFRASTRUCTURE

Poor infrastructure in terms of outdated hardware and software, low-performance graphic processing units and hardships in connecting old machines to the IoT environment hamper the growth of digital twin

## CONNECTIVITY

There is a need for high-speed ubiquitous connectivity, improved reliability and an ultra-low power consumption communication interface. Other issues include power outages, IoT-related software failures and errors in technology deployment

## COST OF IMPLEMENTATION

Installation and maintenance of high-performance infrastructures, such as sensors and graphic processing units can result in high costs. Costs to reimagine workflows and train human resources will require additional investments

## PRIVACY AND SECURITY

Data-sharing platform carries risks of security breaches, data loss and cyberattacks. Associated vulnerabilities will increase substantially when multiple digital twins are amalgamated

## INACCURATE MODELLING

AI is still in its nascent stages and lacks behind in accurate modelling of objects in order to capture their properties, simulate and predict their behaviors in real-time, which pose as a challenge in effective collaboration in using digital twin

## DATA QUALITY

Substantial volumes of unstructured data raises the challenge of quality of data and cost-effective sorting and organizing of data streams. AI/ Machine learning models suffer from overfitting and underfitting of the data leading to poor quality of output

# Conclusion

## Digital twin has the potential to become a necessity in the data-driven decision-making process across multiple industries

- Digital twin is an emerging technology and in combination with IoT, AI/ Machine Learning, and other enabling technologies, it can provide generational improvements of products, reduce time to market, and enhance supply chain agility and resilience
- Early-stage uses in various industries have shown promising results in system monitoring, product prototyping, and asset lifecycle management
- However, the technology is still in its early stages of development and faces significant challenges before it can reach its full potential
    - Hardware, information complexity, costs, and immature supporting technologies, like high-speed connectivity and AI/ML data analysis, require further improvement
- As the supporting technologies advance, these obstacles will become easier to overcome giving way to a more stable and holistic ecosystem for digital twin

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