# Technology deep dive: Digital twins

Virtual engineering within design process | Performance optimization of operating assets

Main opportunities

## Description of technology

A digital twin (DT) is a digital replica of an asset that integrates data from both the digital and physical world to enable:

- virtual engineering within the product-development, manufacturing-process-planning, tool-development, and serviceability-cost-optimization processes
- performance optimization of operating assets

By integrating end-to-end data from design, engineering, manufacturing, and service functions, simulations can mimic the desired state of an asset or its behavior in real-world scenarios.

Insights accelerate management's decision making or automatically optimize behavior.

## Technology maturity

**Technical maturity** — Fundamental research ——●—— Mass adoption

By 2022, the use of DTs will have increased by **3×**[1] with **70%** of manufacturers applying it regularly

## Industry applicability

**Industry applicability** — Niche ——●—— Industry cross-cutting

## What it enables companies to do

***Enhanced predictivity***
Different modeling techniques allow forecasts of future states along predefined scenarios

***Performance tracking and continuous improvement***
Implementing a DT allows consistent collation of an asset's performance history, enabling continuous improvement of linked assets and processes

***Visibility across asset landscape***
As a DT combines various data, intra-asset effects and dependencies become transparent

***Enable automation***
Decision points can be codified and automated based on insights from DTs, reducing number of iterations between decision makers

***One data lake***
Creating a DT requires a common data source, forcing companies to reorganize their methodology of data collection and analysis, which will facilitate additional digitization and optimization possibilities

## Example use cases

**I** ***Accelerate time to market***
Simulate design options without need to build infrastructure or product, allowing design virtualization, development, and testing (eg, simultaneous engineering to derive manufacturing-driven design decisions)

**II** ***Enhance quality of product or service development***
Base various design choices in performance simulations even before real-world testing (eg, multiphysics simulation)

**III** ***Improve EBITDA***[2]
Reduce operating costs (eg, through informed process planning) and increase revenues (eg, increased performance of products/services)

***Reduce capital-intensive investments***
Build investment decisions on simulation insights, reducing risk of redundancy or replacement (as it is designed to purpose)

***Increase project certainty***
Simulate outcomes of possible pathways, tracking performance, and matching with milestones to course correct in time, if there is a deviation from plan (eg, for complex projects in construction)

1. Compared with 2018.
2. Earnings before interest, taxes, debt, and amortization.

Source: Expert interviews; Gartner IoT implementation survey (2018); *IDC FutureScape: Worldwide IoT 2018 predictions*, IDC, October 2017

# Use case deep dive: Digital twins

Proof points

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| Use case | Situation and approach | Impact |
|---|---|---|
| I **Accelerate time to market** | Automotive OEM bottlenecked from sequential design decisions<br><br>Particularly, design of seat-belt-fastening systems took 3+ days, extending total design timeline | Digital twin (DT) model set up with constraints and goals from design and engineering teams<br><br>Reduced time to find optimal design choice to >1 minute |
| II **Enhance product or service development** | Philips produces medical-imaging gadgets (eg, MRIs)<br><br>Physicians have difficulties reconstructing and interpreting the anatomy of a patient's heart from a set of 2-D images | A digital patient twin creates 3-D heart models, providing in-depth specifications and dynamics of individuals' hearts<br><br>Heart model decreases time to operation by **82%** compared with using 2-D medical images |
| III **Reduce operating costs** | Carson City, NV, in US suffers from occasional water shortages in peak periods<br><br>City has implemented a DT to simulate future water supply (eg, based on high usage hours) to fulfill water availability and save on operating costs | DT provided insights to rebalance water provision across **3** counties, now controlling it automatically<br><br>Reduced operating staff hours by **15%,** ensuring reliable water provision to **50,000** citizens |

Source: Expert interviews; McKinsey analysis

# Expected technology-development horizons: Digital twins



## Expected technology-development horizons in next 5 years

### Democratization of simulation-based digital twins across industries

Growing availability of "Digital twin (DT) as a service" through big tech companies (eg, Microsoft Azure) to drive use-case development

Lighthouse use cases with clear business benefits (eg, in machine-operation optimization in manufacturing) motivate exploration across industries

### Enhanced end-to-end decision making and optimization

Connecting DT insights across application stages, ranging from design to aftersales (end-to-end or E2E)

Insights are packaged and visualized to support management integrating with user technologies (eg, mixed reality)

E2E coverage of DTs enables optimized automation of processes, generating second wave of efficiency gains

### Autonomous, asset optimization & continuous manufacturing

Blurring lines between discrete and continuous manufacturing, given AI-driven process optimization and control of machines (eg, robots)

DTs will act as smart software driver for physical assets by integrating in the Internet of Things (IoT)/ edge environment, allowing real-time analysis, feedback, and implementation

Deployment of DT across ecosystems and supply chains, requiring full digitization of application environment (eg, customer relationship or value chain)

## Enablers

Increasing number of data points from sensors (eg, light detection and ranging [LIDAR] sensors) or third-party reference data paired with greater sophistication of simulation

Growing interoperability across applications, platforms (eg, Microsoft Azure), and sensors (eg, for IoT)

Availability of affordable computing resources on demand and preconfigured; adaptable models accelerate testing of use cases

Continuous marginalization of improvements from mechanical-productivity levers, especially in developed economies, requires data-driven, real-time optimization to exploit remaining efficiencies

## Barriers

Missing mindset for continuous optimization and ongoing data collection

Lack of common data analysis and security standards within as well as across industries and organizations that limits immediate opportunities

Organizational hesitation to expand optimization efforts across owned value chains but integrate with suppliers to share data insights

Mismatch of insights from DTs with asset lifetimes given that validity of insights is short term while assets are rigid and likely to endure for longer, likely leading to incompatibility or accelerated obsolescence of assets (eg, machines with long life cycles may not be able to adapt behaviors to insights)

Source: Expert interviews; Fauenhofer Institute; McKinsey analysis