WHITE PAPER

SIMULATION DIGITAL TWINS, IoT, AND THE CLOUD

THE NEW NEXUS OF VALUE CREATION

COSMOTECH
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Welcome to the new normal: it’s volatile, it’s uncertain and it’s complex

In such a challenging and dynamic market, decision makers increasingly need to predict all possible futures so they can lead in change and navigate challenges while creating new worlds of opportunity. Executives turn to technology to generate, report, store and analyze the data they need to make optimal choices, with the explosion of the Internet of Things (IoT) a testament to this trend. Pushing this data to the cloud has become common with the largest cloud providers competing to help power the data-driven and technology-leveraging decision making that is driving innovation across all industries.

But IoT data and cloud tools alone are insufficient to power transformation and deliver success in the new normal. Accurately predicting a future that does not closely resemble the past is only possible with another technology, the Simulation Digital Twin. In a rapidly shifting business landscape only Simulation Digital Twins enable decision makers to react in real time to disruptions and gain visibility on the impact of their choices and set course for a more efficient, resilient, and sustainable future.

And so, it’s here at the nexus between IoT, the cloud, and Simulation Digital Twins that the world’s most innovative, successful, and sustainable companies can be found.

In this White Paper we explain how Simulation Digital Twin technology is key to generating a return on investments in IoT and the cloud, and demonstrate how leading companies are already building an enviable record of success while charting their way through the stormy sea that is the new normal.

Hugues de Bantel,
Co-founder & CEO, Cosmo Tech

Contents

An Introduction to Simulation Digital Twins

A digital twin is a virtual representation that serves as the real-time digital counterpart of a physical object or process. While the terminology has changed over time, the basic concept of a digital twin model has remained fairly stable from its inception in 2002. For many people though, the words ‘digital twin’ conjure up an image of a 3D model of a physical object, yet this is rarely the case. Instead, these twins are simply digital representations of an individual asset, machine, or equipment piece; no 3D model or graphical representation is necessarily required, with many digital twins displaying nothing more graphically engaging than a dashboard.

As the trend towards adoption of digital twins gains momentum and the digital twin ecosystem rapidly expands, a new class of digital twins has appeared. More than just a representation of a single asset or machine, these new digital twins can model entire organizations, interconnected processes, and complex systems based on the evolving dynamics of the day-to-day operations of a business. Drawing on the power of simulation to accurately predict the future state of these complex systems, they are known as Simulation Digital Twins.

Simulation Digital Twins incorporate three fundamental advances to address the systemic challenges of making optimal choices in the world’s most complex industrial environments:

A 360° holistic view:

Simulation Digital Twins can virtually replicate an entire ecosystem including all elements of an organization. A Simulation Digital Twin can reconcile all the different views needed when making decisions in the face of multiple contradictory constraints.

Dynamic simulation:

With world’s best simulation capabilities, Simulation Digital Twins allow users to project the evolution of their organization in both the short and long term.

Opportunity to connect and synchronize in real-time:

Simulation Digital Twins can be connected to real world data sources and synchronized in real-time from previously disparate devices and systems. IoT networks can feed data into the twin and decision making can be automated based on the outcomes of thousands of simultaneous simulations.

An Exploding Market in Digital Twins

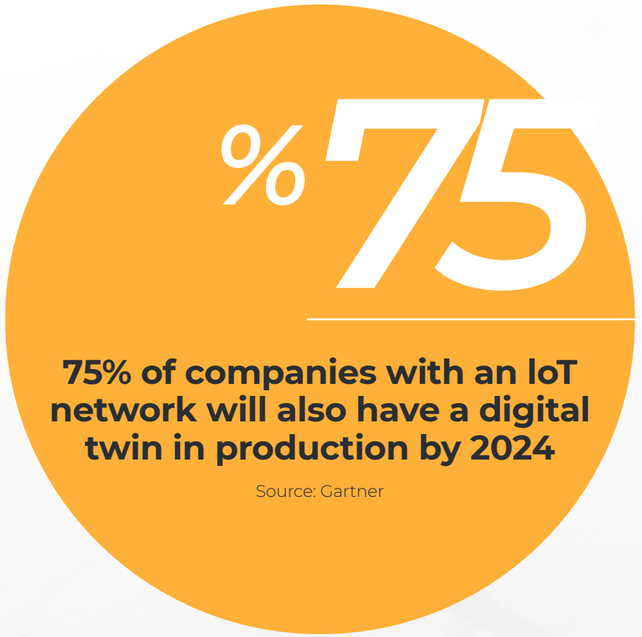
Five years ago the organizers of the famed Hannover Messe published an article suggesting that digital twins were poised to revolutionize industry. Today, we are in the midst of that revolution and there are billions of digital twins helping industry leaders make smarter, better informed decisions.

Digital Twins are one of the Top 5 Strategic Technology Trends to watch in 2021

Source: Accenture

The global digital twin market is expected to exceed $86 billion by 2028

Source: Grand View Research



75% of companies with an IoT network will also have a digital twin in production by 2024

Source: Gartner

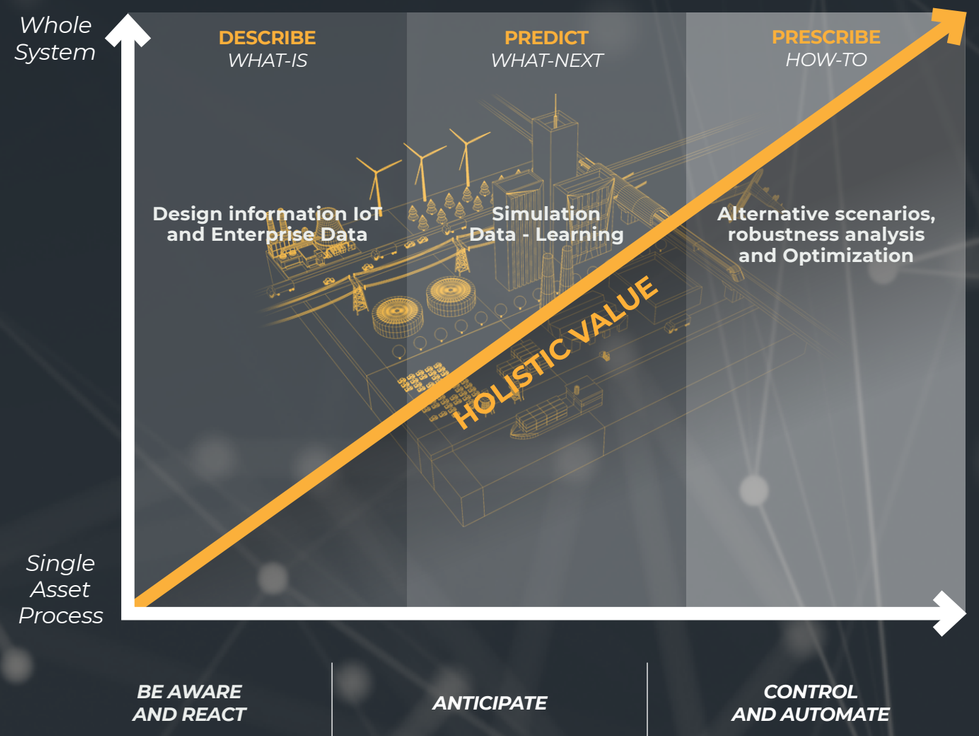
The Holistic Approach to Simulation Digital Twins

Modern businesses are interconnected wholes and any effort to achieve strategic goals that do not recognize and leverage the whole of the organization are bound to be suboptimal, if not prove to be a failure altogether.

Simulation Digital Twins recognize the value of addressing complex business challenges holistically and offer insights at three different levels of understanding. Simulation Digital Twins take a truly holistic approach to the network and consider all the diversity and heterogeneity of the real system such as assets, teams, environmental and regulatory policies, investment budget constraints, as well as external events such as weather conditions, external supplier constraints or the evolution of customer demands.

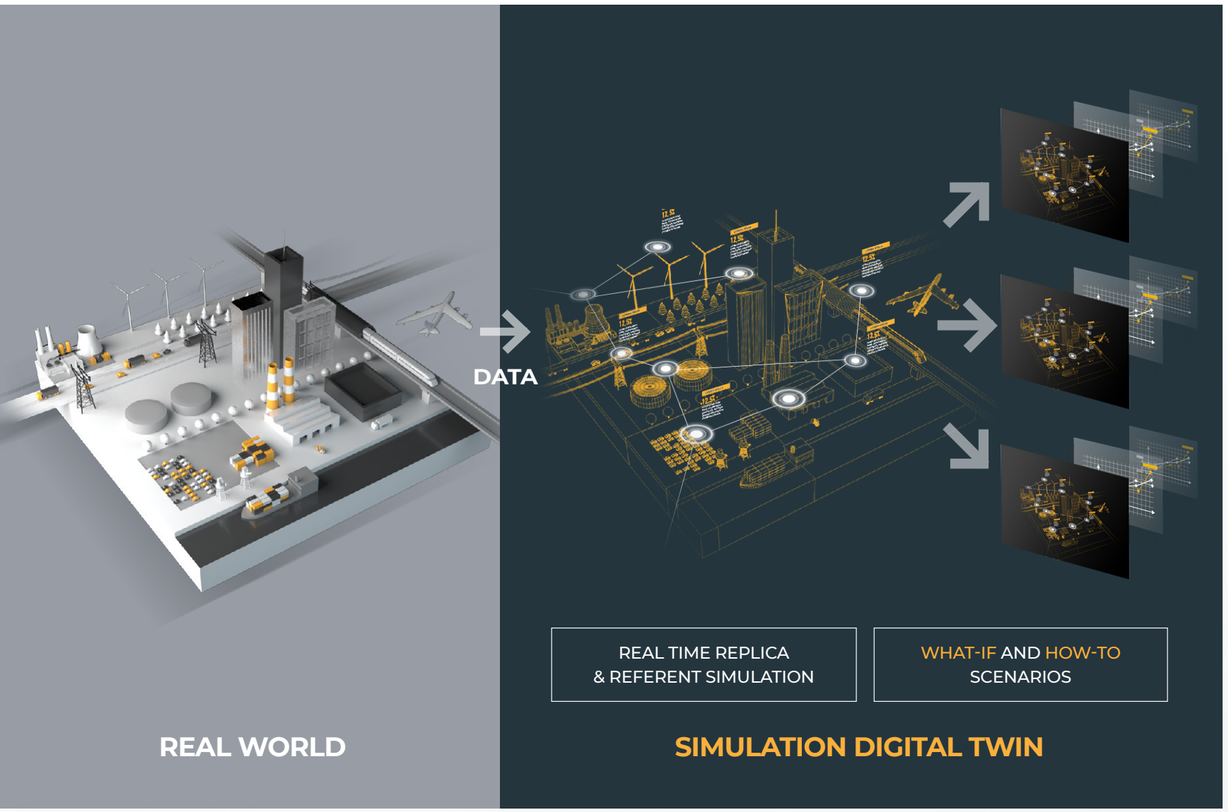
The first level of understanding describes what exists and what is happening in the corporate system right now. The second level of understanding explores predictions of all possible futures for the system, even if those futures have never occurred before. The third level of understanding generates optimized action plans to achieve the tactical and strategic objectives of the company. By combining these three levels, Simulation Digital Twins help organizations move from reaction to anticipation, to achieve better control of their systems, and even achieve a certain level of automation as they improve their overall performance.

The more that a digital twin allows companies to understand and optimize their decision making (horizontal axis) in a holistic way while also considering all the complexities of their reality and all of their constraints (vertical axis), the greater the level of understanding and the more holistic value will be unlocked.



Simulation Digital Twins in Practice

Simulation Digital Twins share some similarities with traditional digital twins but also some significant differences. In the example below – a production hub in the automotive sector – it is possible to understand how a Simulation Digital Twin works and the enormous value that it can unlock for industrial organizations.

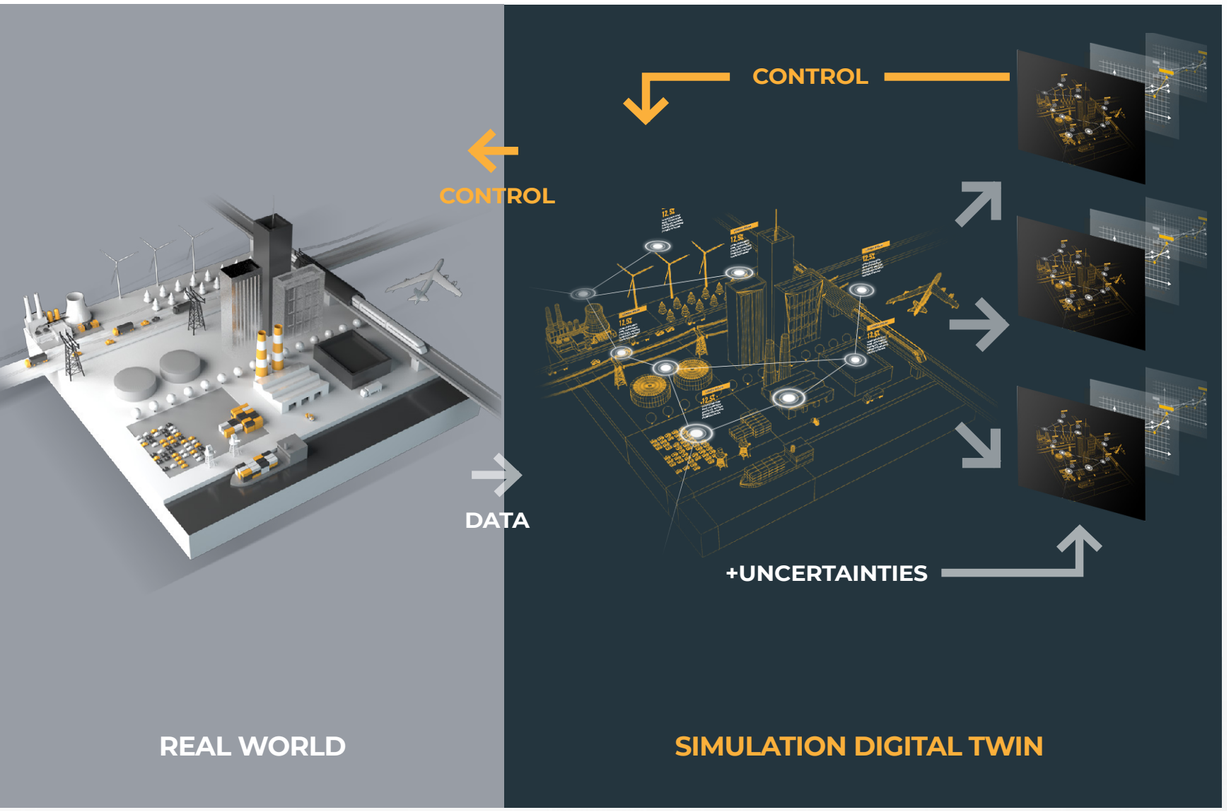


The real-world production hub is represented on the left of the image, with the Simulation Digital Twin of that production hub represented on the right. A model of the organization is created that includes the processes, human resources, CO2 usage and any other business constraints. Then data about the state and operations of the real-world production hub flows from the hub to the digital twin. The sources of this data can be IoT sensors or other connected devices, or even enterprise software systems for finance, human resources, and other business operations departments.

The data is used to run a baseline scenario simulation that allows the user to see how the current system will evolve over time. At this stage bottlenecks, congestion points or underperforming elements can be rapidly detected. The time frame for this simulation is flexible and can be as short as the next 30 minutes or as long as the next 30 years.

After running the baseline simulation and having identified what the ‘business as usual’ outcomes will be, users can test additional scenarios with any number of different assumptions and configurations. These ‘What-if’ scenarios represent variations on the future and predict the impact of any single decision (for example, the consequences of strong demand increase on production output), expected event (for example, a re-tooling period or maintenance shutdown) or a feared event (for example, a fire or raw material supply disruption).

As the exact future remains unknowable, the results of the scenarios can be evaluated according to thresholds defined for specific business goals, such as risk or performance KPIs. To create robust plans users can include uncertainties and demand variations directly in the simulation.



When an optimal scenario has been identified, the Simulation Digital Twin can generate a ‘How-to’ plan that outlines what actions are necessary to achieve the desired end, and how these actions impact the system. These ‘How-to’ plans provide an optimized and executable action plan, calculated specifically for the chosen KPIs, with every step in the plan described in full.

With a ‘How-to’ plan in place, data from the system is fed back into simulation again. With the Simulation Digital Twin fully connected to the real-world system in a bidirectional manner, the simulations inform real-world decisions and the data that flows from those decisions flows back into the twin to further optimize and adapt. This feedback loop can allow for increasing automation of real-world decision making so that operations in the production hub are fully optimized and productivity, robustness, and resilience all continue to improve with time.

The Convergence of IoT and Simulation Digital Twins

IoT devices have traditionally been leveraged for real-time monitoring and automation, reducing drastically the time it takes to react to different events.

In a manufacturing environment, for example, data gathered in real-time from an IoT sensor network might aid with real-time machine monitoring, predictive maintenance or production visibility on that line. IoT and especially IIoT - Industrial IoT - is today considerably accelerating the convergence of Information Technology (IT) and Operational Technology (OT). For the first time, OT is a direct part of IT. IDC points out that by 2024, 70% of G2000 organizations will have invested in a common IoT platform layer that provides access to data collected through various point solutions.

Connected industrial and manufacturing parts or equipment support improved maintenance cycles, security and efficiency. However, IoT's real-time ability to communicate status and its combination with Edge computing's ability to trigger alerts need to be integrated into the customer's overarching manufacturing strategies and resource planning to enable performant automation in production and thus, prove more valuable.

Connected factory data generated by IoT sensors must be correlated with other corporate data and directly analyzed in the context of the organization as a whole. "To be truly valuable, factory floor data must be integrated throughout the entire value chain" said Enno de Boer, who heads McKinsey's work in digital manufacturing. "With better use of analytics, tailored production will influence everything "from component sourcing through to last-mile delivery."

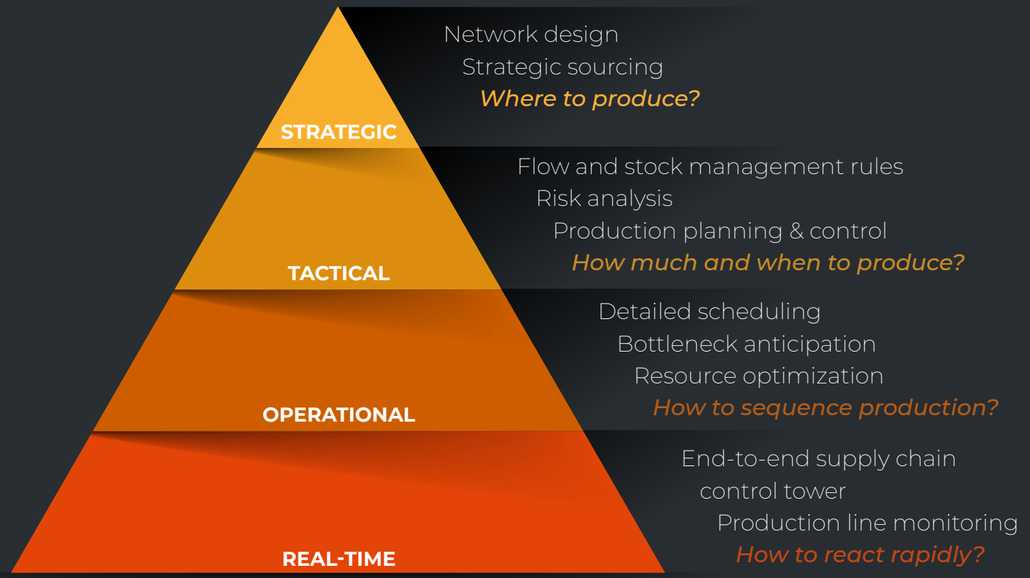
This journey to adopt modern real-time analytics will help companies reduce the time required to react and plan their actions across the organization and will bring tremendous business value from a faster decision-making process and increased agility. The key requirements to implementing this journey and to achieving those goals are to: develop a connected environment that is integrated into regular organization processes, business applications and operational systems (ERP, MES, EAM and others), transition from transactional planning to a truly digital, dynamic planning from operational to strategic, develop a capacity to test scenarios and identify in real time optimal and robust plans based on the current situation and context.

A Single Source of Truth for All Planning Levels

C-Level reporting
Strategic view &
consolidated data

Multi-Scale approach
for full alignment

Monitoring & Control
Real-time sync with
IT/OT/IoT sources



Our connected Simulation Digital Twins are providing the capability to leverage modern real-time interconnected ecosystems to test any possible scenario and provide visibility on what the future will be. This serves advanced prediction & prescription across the whole organization, from the business leaders and production planners to front-line workers in the factory.

When using IIoT data in a Simulation Digital Twin, organizations are able to simulate detailed operations in the context of the whole manufacturing process, predict the impact of real-time information on coming operations or performance KPIs and take the right actions for smart planning and manufacturing.

The convergence between IoT and Simulation Digital Twins represents a convergence between two worlds – the real-world physical environment of the IoT network and the holistic digital representation of this world in the form of the Simulation Digital Twin. When taken together this enables optimized decision making on every level: real-time, operational, tactical, and strategic. This convergence adds significant value to existing investments in IoT networks by providing higher utility and a greater return on an investment in data, while concurrently generating large quantities of simulated data that can itself be used for machine learning and AI training.

Cosmo Tech and Microsoft

Organizations will also need the ability to simulate anything. And they will need to be able to automate everywhere, to enable faster, more agile response.

Satya Nadella
CEO, Microsoft

Delivering value at the nexus of IoT, Simulation Digital Twins, and the Cloud means developing powerful world-class partnerships with other technology providers. For Cosmo Tech and its market-leading Simulation Digital Twin technology, the best partnership was clearly Microsoft with its Azure Cloud Platform and Azure Digital Twin offers.

Microsoft and Cosmo Tech share a common vision of the importance of simulation as well as a deep integration between their technologies. A seamless mapping has been defined between languages to accelerate the usage and creation of simulable domain ontologies. These common ontologies make the integration between Microsoft's Azure Digital Twin and Cosmo Tech's Simulation Digital Twin seamless, with the end result being the most powerful platform available for the world's most complex industries.

Cosmo Tech's simulation platform is fully model driven and allows the rapid and automatic generation of a high-performance executable simulation engine from the Simulation Digital Twin model. This modeling process is highly efficient as only 20% of the code required for the simulation needs to be generated in each new use case. What's more, it has the capacity to retain a 1:1 mapping between Microsoft's **Digital Twins Definition Language** (DTDL) objects and Cosmo Tech's **CoSML** objects. The alignment between Microsoft and Cosmo Tech means that an advanced user (ie: modeler) can work from Azure Digital Twin ontologies and directly add dynamic behaviors to the model or start from the Cosmo Tech simulation model and general a DTDL model from there. Finally, sharing common ontologies between Cosmo Tech and Microsoft's Azure Digital Twin is the key to ensure that Simulation Digital Twins are always in-sync with operational systems guaranteeing efficient decision making, automation or auditing.

The combined Cosmo Tech and Microsoft platform leverages cloud-native technologies like containers, Kubernetes, microservices, serverless functions and API-centric design. Initializing the simulation is done by taking a copy of the Azure Digital Twin graph and combining it with the scenario parameter to be evaluated on top. The execution of the simulation engine is scaled by Azure Kubernetes Services, enabling the optimization by simulation of use cases that can require tens, thousands or even hundreds of thousands of simulation runs to identify the best parameters.

Finally, Cosmo Tech uses the Azure Data Explorer and PowerBI for storage and visualization of the simulation results, offering insights to users at any level of granularity – from individual asset to global industrial system – over the entire course of the chosen time period.

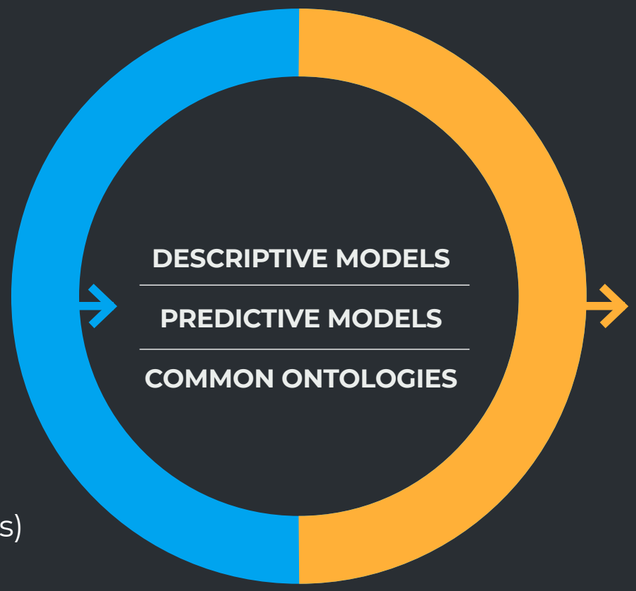
The result of the combination of Microsoft's Azure Digital Twin with Cosmo Tech's Simulation Digital Twin is deep integration to IT and OT environments and connectivity to all of the operations data reported by IoT networks.

Democratizing Connected Simulation Digital Twins

Microsoft Azure

TRACK THE PAST → **MONITOR** THE PRESENT

For detailed, comprehensive data modeling
of physical environments,
connected to the real world
(two-way communication to IoT and Edge devices)



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PREDICT THE FUTURE → **TAKE ACTION**

For 360° prescriptive simulation
with one single decision modeling
(Including physical data, processes,
constraints of the organization
and their interactions)

About Cosmo Tech Simulation Digital Twin Technology

What do our clients use Simulation Digital Twins for?

1 | **Anticipate Disruptions**
Develop scenarios that involve disruptions in your system to plan for the future. By running simulations including the likes of machine breakdowns, workers' strikes, and increased costs, you can anticipate how to recover quickly in these events.

2 | **Improve Decision Making**
Uncover which range of parameters and processes to adjust in your digital twin to make complex decisions with confidence. At a glance, view all the variables that go into decision making, and assess the cascading effects that might take place upon altering them.

3 | **Balance Sustainability and Profitability**
Predict the environmental impact of each scenario and find emission-reduction opportunities. Find the optimal trade-off between cost, performance, risk of failure and sustainability and plan efficiently for the future.

4 | **Reduce Risk and Increase Profit**
Understand the risk associated with your decisions and make the choices that will allow you to minimize your exposure to that risk while maximizing your opportunities to operate profitably.

CoSML

Cosmo Tech's proprietary Complex Systems Modeling Language (CoSML) is core to its capacity to model and simulate physical assets, industrial systems, procedures, and processes. CoSML is a unique and powerful technology which represents a real system with reference to four key components of that system.

The concepts and behaviors in a system are represented by CoSML as entities, along with their associated state and rules.

These entities are then grouped into subsystems as hierarchies, and each hierarchy is represented as its own entity in the broader system, too. Each hierarchy has its own rules, state, dynamics, and timescale, and this corres- ponds to vertically-structured complexity.

The interconnections between entities are represented as interactions. These can be either structured or unstructured, and each interaction has its own rules, state, dynamics, and timescale just as the hierarchies do. This corresponds to horizontally-structured complexity.

Finally, the dynamics of a system are the actions performed by a component in that system (entity, hierarchy, interaction) along with the relevant timescale. CoSML allows for dynamics at various timescales to exist in the same model, and the actions within each dynamic can be scheduled in parallel or in sequence.

About Cosmo Tech

Cosmo Tech provides
a 360° Simulation Digital twin platform

We offer an innovative approach to predict all possible futures of an organization, to solve the most complex industrial problems and lead enterprise decision making.

Industrial companies in manufacturing, energy & utilities and mobility rely on Cosmo Tech to better understand the impact of their decisions and ensure a future that is robust, resilient and sustainable.

Holistic, dynamic and connected digital replicas to simulate entire business ecosystems

Our Simulation Digital Twin platform leverages both predictive and prescriptive analytics. Decision makers have a 360° view of their process. They can run unlimited scenarios to better understand the current behavior of their complex organization, anticipate all possible situations even under conditions that have never occurred before, and gain optimization of all levels of enterprise planning.

$27 million
Series A and B
venture capital funding

2010
Cosmo Tech founded

Gold Microsoft Partner

Microsoft

MEMBER digital twin CONSORTIUM Member since 2020

Gartner

2020: Sample Vendor for Digital Supply Chain Twin Technology in Supply Chain

2019: representative Vendor of Digital Twin of an Organization

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