DEXORY
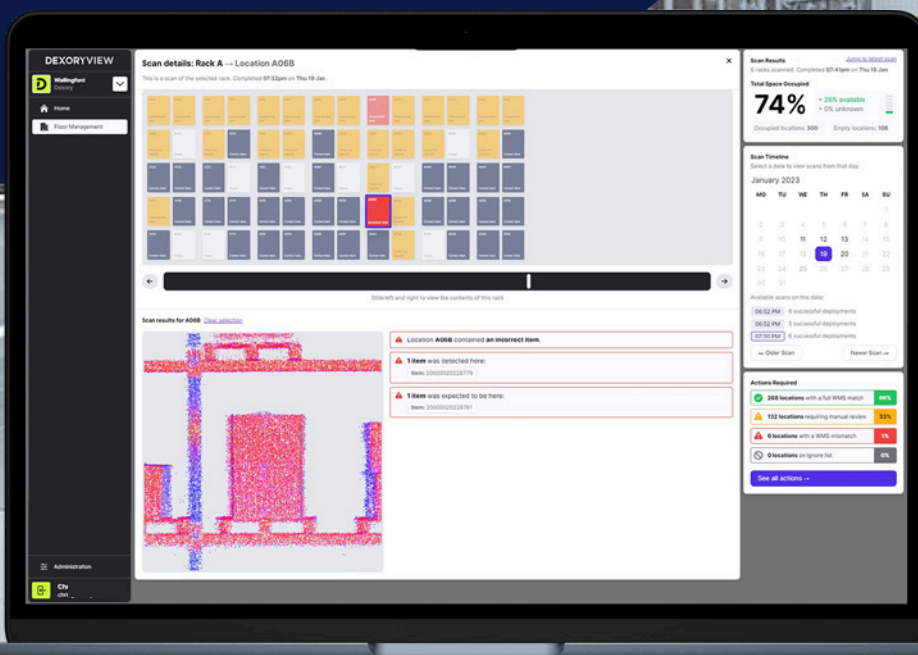
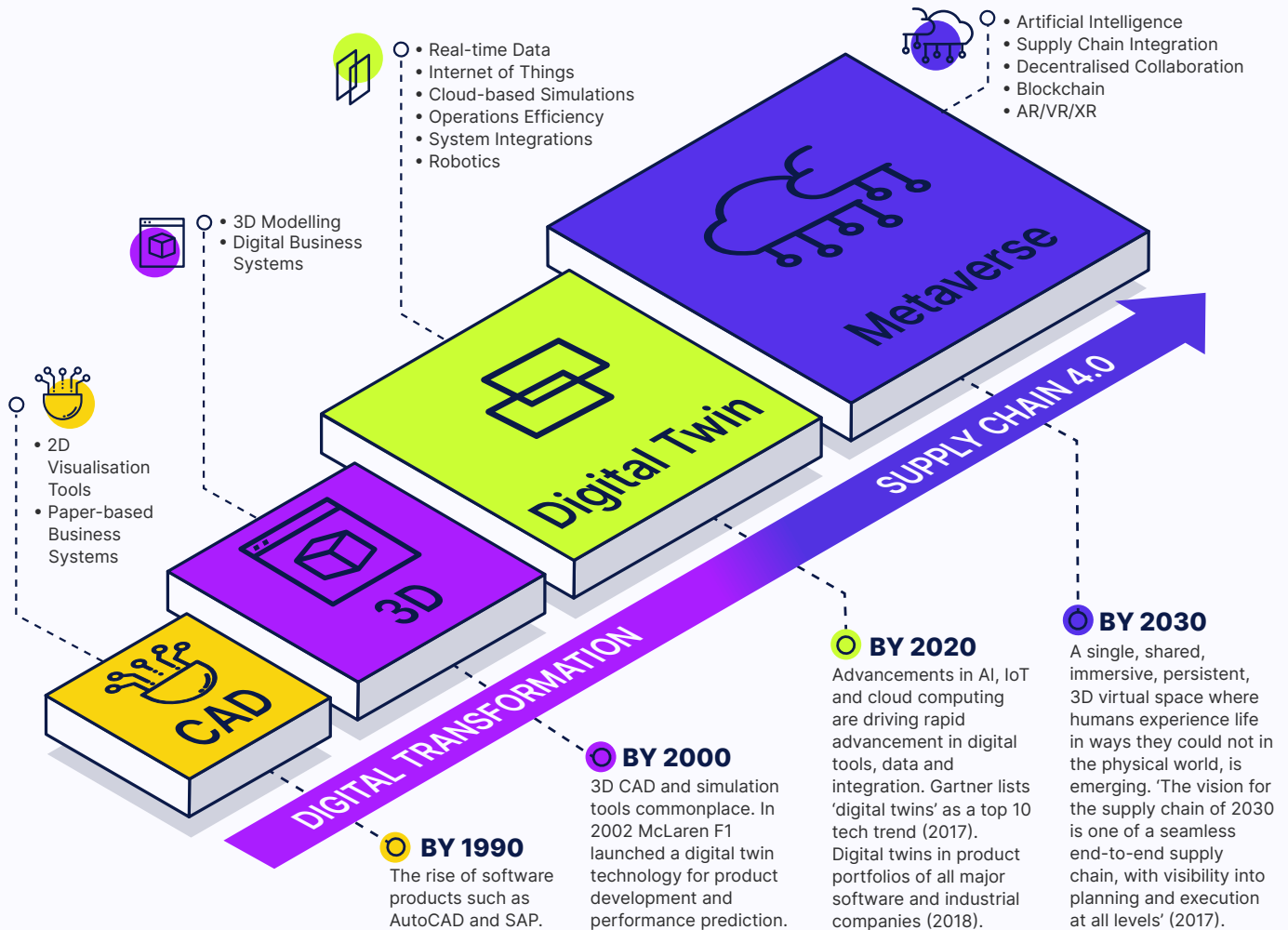# Digital twins

How data-led intelligence and digital twins are driving innovation in warehouses

Introduction

Evolution of digital twins

• Real-time Data
• Internet of Things
• Cloud-based Simulations
• Operations Efficiency
• System Integrations
• Robotics

• Artificial Intelligence
• Supply Chain Integration
• Decentralised Collaboration
• Blockchain
• AR/VR/XR

• 3D Modelling
• Digital Business Systems

• 2D Visualisation Tools
• Paper-based Business Systems

Metaverse

Digital Twin

3D

CAD

SUPPLY CHAIN 4.0

DIGITAL TRANSFORMATION

BY 1990
The rise of software products such as AutoCAD and SAP.

BY 2000
3D CAD and simulation tools commonplace. In 2002 McLaren F1 launched a digital twin technology for product development and performance prediction.

BY 2020
Advancements in AI, IoT and cloud computing are driving rapid advancement in digital tools, data and integration. Gartner lists 'digital twins' as a top 10 tech trend (2017). Digital twins in product portfolios of all major software and industrial companies (2018).

BY 2030
A single, shared, immersive, persistent, 3D virtual space where humans experience life in ways they could not in the physical world, is emerging. 'The vision for the supply chain of 2030 is one of a seamless end-to-end supply chain, with visibility into planning and execution at all levels' (2017).
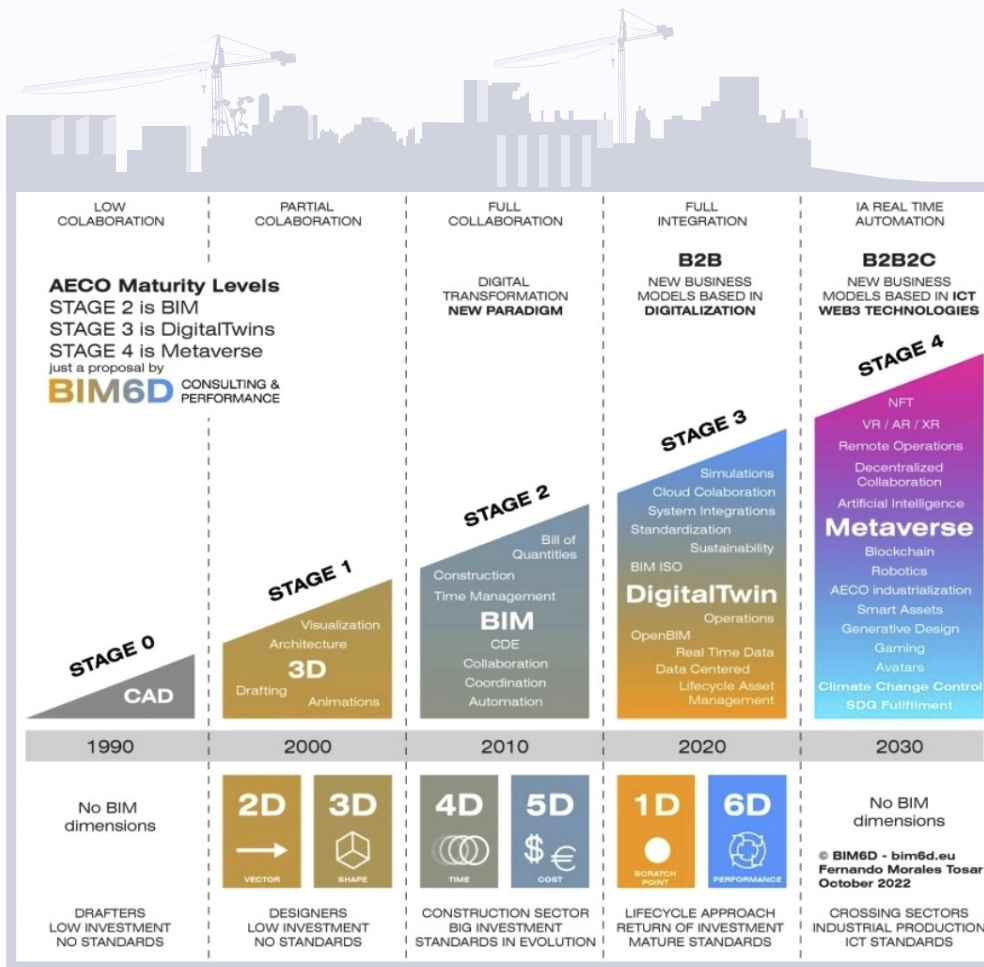
1 A digital twin is a real-time (or near real-time) virtual representation of a physical asset, system or process that exists in the real world.

2 Digital twin data-rich solutions enable accelerated access to value-adding strategic and operational data insights.

3 Digital twins help companies better use their processes, equipment and product data. They deliver a veritable step-change in operations and can boost profitability.

AECO Maturity Levels
STAGE 2 is BIM
STAGE 3 is DigitalTwins
STAGE 4 is Metaverse
just a proposal by
BIM6D CONSULTING & PERFORMANCE

LOW COLABORATION	PARTIAL COLABORATION	FULL COLLABORATION	FULL INTEGRATION	IA REAL TIME AUTOMATION
		DIGITAL TRANSFORMATION **NEW PARADIGM**	**B2B** NEW BUSINESS MODELS BASED IN **DIGITALIZATION**	**B2B2C** NEW BUSINESS MODELS BASED ON **ICT WEB3 TECHNOLOGIES**

STAGE 0 — CAD

STAGE 1 — Visualization, Architecture, **3D**, Drafting, Animations

STAGE 2 — Bill of Quantities, Construction, Time Management, **BIM**, CDE, Collaboration, Coordination, Automation

STAGE 3 — Simulations, Cloud Colaboration, System Integrations, Standardization, Sustainability, BIM ISO, **DigitalTwin**, Operations, OpenBIM, Real Time Data, Data Centered, Lifecycle Asset Management

STAGE 4 — NFT, VR / AR / XR, Remote Operations, Decentralized Collaboration, Artificial Intelligence, **Metaverse**, Blockchain, Robotics, AECO industrialization, Smart Assets, Generative Design, Gaming, Avatars, Climate Change Control, SDG Fulifilment

1990	2000	2010	2020	2030
No BIM dimensions	**2D** VECTOR / **3D** SHAPE	**4D** TIME / **5D** COST	**1D** SCRATCH POINT / **6D** PERFORMANCE	No BIM dimensions © BIM6D - bim6d.eu Fernando Morales Tosar October 2022
DRAFTERS LOW INVESTMENT NO STANDARDS	DESIGNERS LOW INVESTMENT NO STANDARDS	CONSTRUCTION SECTOR BIG INVESTMENT STANDARDS IN EVOLUTION	LIFECYCLE APPROACH RETURN OF INVESTMENT MATURE STANDARDS	CROSSING SECTORS INDUSTRIAL PRODUCTION ICT STANDARDS

It might surprise you that the concept of modelling the real world is not new. The first known reference dates back to between 3000 – 6000 BC, and it consists of the models of buildings and dwellings from the Trypillian Culture in the regions that now represent the territory of Ukraine.

In the modern era, digital representations of physical entities have been explored since the dawn of computers in the 1950s. As mathematical models progressed into CAD in the 1960s, an excellent example of this technology powering advancements and efficiencies came from General Motors, who partnered with IBM. They created the DAC-1, Design Augmented by Computer, which was seen in 1964 and used for the rest of the decade by General Motors to accelerate its car production processes. This proved that using computers for design visualisation reduced workloads that would have otherwise taken enormous time if drawing boards were used.
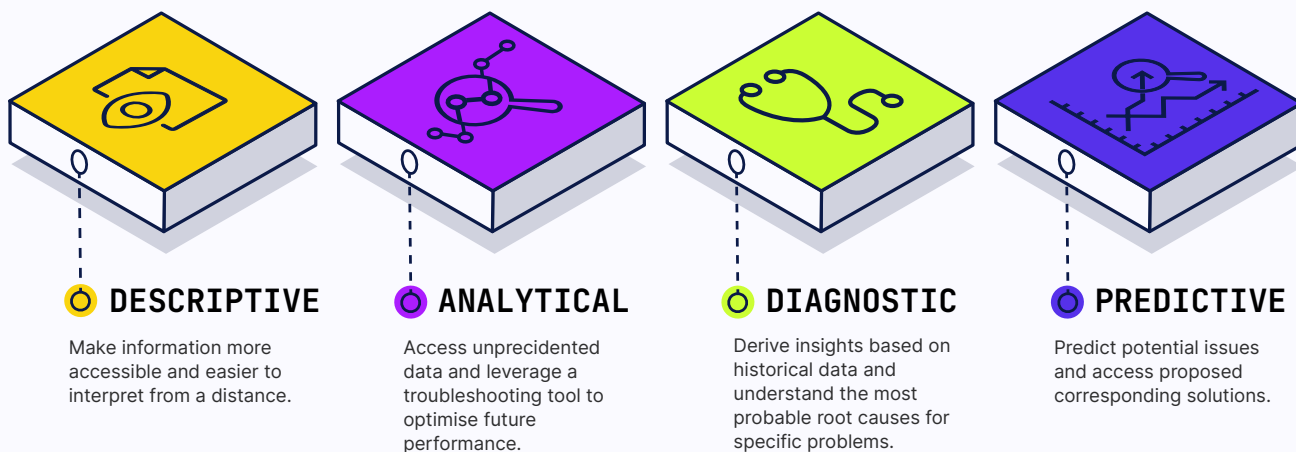
With the publication of The IRM Imperative (Wiley & Sons, 1991) by James M. Kerr, the idea of managing and putting a monetary value on an organisation's data resources and then reporting that value as an asset on a balance sheet became popular. Kerr described a way to populate subject-area databases from data derived from transaction-driven systems to create a storage area where summary data could be further leveraged to inform executive decision-making. This concept promoted further thinking of how a data warehouse could be developed and managed practically within any enterprise.

Jump forward to 2002 and Michael Grieves originated the modern-day concept of the 'digital twin'. He is commonly known as the father of digital twins. Then in early 2018, European software company, Dassault Systèmes finished building a digital twin of Singapore 3DEXPERIENCity. It enables users from different sectors to develop sophisticated tools and applications for test-bedding concepts and services.

The construction industry has been developing digital twins for over a decade, aiming to enable more efficient and collaborative construction lifecycles. The data collated, visualised and interpreted can be used to make better decisions throughout the design, scheduling, construction, occupation and maintenance stages of a building's life. For example, running simulations on the data for construction site scheduling is a really powerful tool.

As you can see on the graphic (above), experts in the field have been charting their own digital transformation, creating a vision for a truly connected and integrated future beyond the data rich models that present-day BIM (Building Information Modelling) delivers.

DESCRIPTIVE
Make information more accessible and easier to interpret from a distance.

ANALYTICAL
Access unprecidented data and leverage a troubleshooting tool to optimise future performance.

DIAGNOSTIC
Derive insights based on historical data and understand the most probable root causes for specific problems.

PREDICTIVE
Predict potential issues and access proposed corresponding solutions.

So how does a digital twin really differ from a 3D model?

One issue is the divide between the digital and the physical world. 3D models represent a moment in time. It is when changes are made physically or to the data used for the simulation. Therefore, the representation is soon out of date.

Developments in technologies such as IoT (Internet of Things), Artificial Intelligence (AI) and Machine Learning have advanced development and capabilities. So today, digital twins don't just reflect how things were designed or implemented originally but can provide a picture of how they are actually operating in real-time, or in the past at a specific moment - or even a predicted simulation of the future!

Digital twins can consist of many different concepts, from full 3D models that visually replicate the real world to dashboards that provide data and interpretation in a user-specific relevant way. Of course, for any of these concepts to maintain an up-to-date digital reflection of a complex process or product requires a continuous stream of rich data.

Digital twins and real-time data

Using a digital twin, companies turn a simulation into a business tool that will increase productivity, optimisation and profitability.

To be truly productive, a digital twin requires three elements:

- The original object
- The digital twin as a virtual object
- The real-time data information.

A digital twin is the virtual model of a real 'thing' in real time:

- A digital twin simulates both the physical state and behaviour of the thing
- A digital twin is unique, associated with a single, specific instance of the thing
- A digital twin is connected to the thing, updating itself in response to known changes to the thing's state, condition, or context.

Real-time data is usually captured by sensors and cameras and fed into an AI platform that connects the twin and the data, giving intelligent insights and helping managers optimise processes while having complete, remote real-time visibility.

A digital twin digitises the data, connects multiple points, unlocking new business opportunities with the provision of advanced services and the generation of valuable insight from operational data.

By leveraging AI-driven digital twins, businesses gain a deeper understanding of their operations and can optimise their supply chain, from sourcing and planning to distribution and logistical processes.

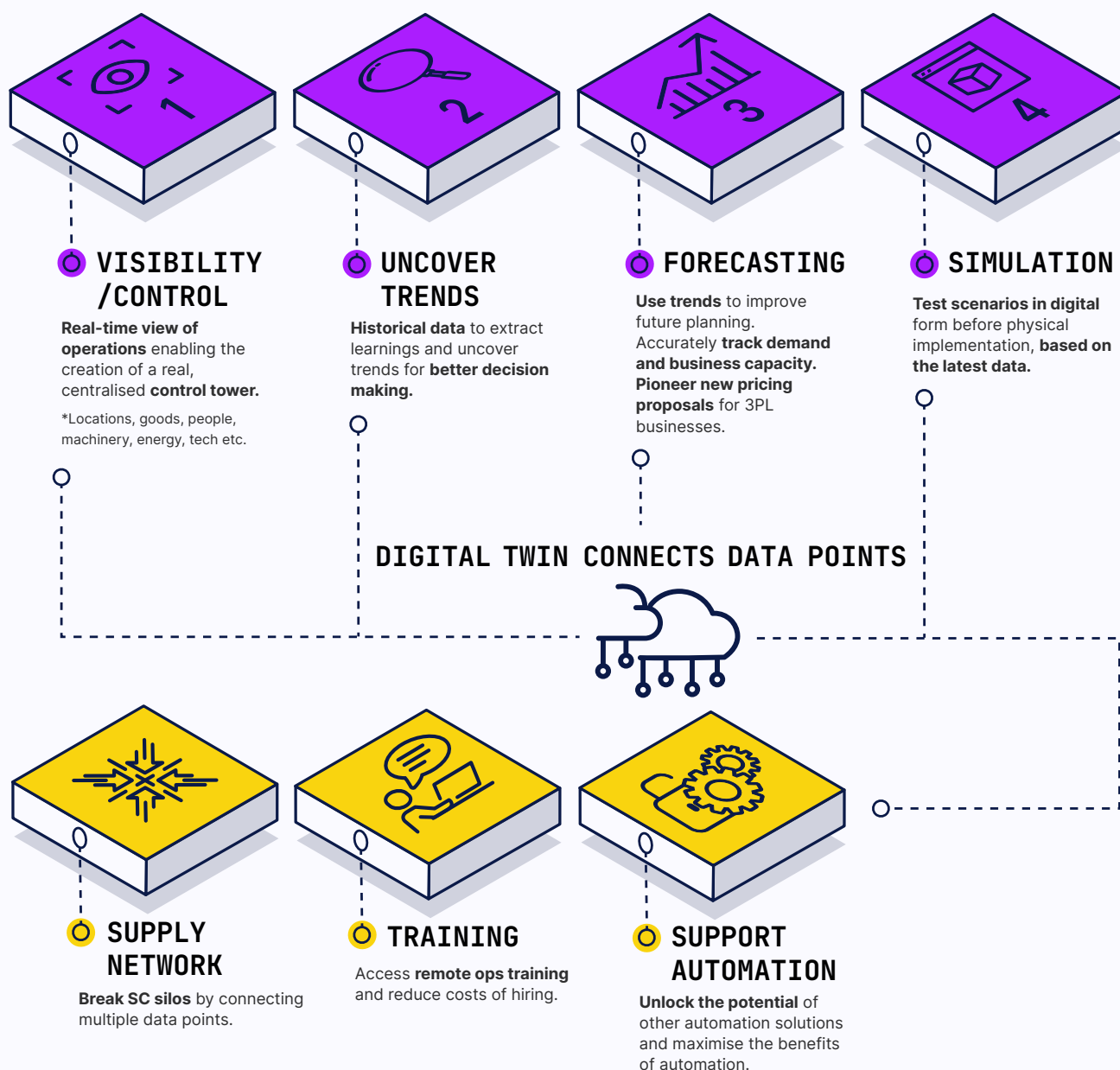# A digital twin future for warehouse operations

Dexory believes digital twins within warehousing and logistics will be vital in achieving greater operational efficiency, profitability and complete supply chain integration.

What is a warehouse digital twin?

To understand a digital twin, we need to look at its predecessor CAD (computer-aided design) twin, a static simulation of something or a full or part of an object. In the case of warehouses, this is sometimes created when an architect designs and builds the space showing what the area will look like. Or it may be created after the warehouse is fully operational. But no matter when it was created, it is usually always static. As changes are made over time, it is rarely updated or altered, often becoming just another file on a server or a printout in a binder.

But this is now radically changing through digital twins, which don't just reflect how something was designed but how it's operating and what is happening daily. The digital twin in this concept can consist of several things, a traditional 3D CAD representation, a 2D drawing or an advanced data dashboard enhanced by a data layer and AI technology. It doesn't matter whether the depicted area exists or will only exist in the future. A digital twin only functions to its full potential if it is maintained with up-to-date digital data, reflecting what is happening in real-time and allowing retrospective analysis. The more real-time data available, the more accurate the twin can be, allowing operational teams to detect issues ahead of time, reducing loss of goods and improving efficiencies and profits.

The benefits of digital twins

1 VISIBILITY /CONTROL

Real-time view of operations enabling the creation of a real, centralised **control tower.**

*Locations, goods, people, machinery, energy, tech etc.

2 UNCOVER TRENDS

Historical data to extract learnings and uncover trends for **better decision making.**

3 FORECASTING

Use trends to improve future planning. Accurately **track demand and business capacity. Pioneer new pricing proposals** for 3PL businesses.

4 SIMULATION

Test scenarios in digital form before physical implementation, **based on the latest data.**

DIGITAL TWIN CONNECTS DATA POINTS

SUPPLY NETWORK

Break SC silos by connecting multiple data points.

TRAINING

Access **remote ops training** and reduce costs of hiring.

SUPPORT AUTOMATION

Unlock the potential of other automation solutions and maximise the benefits of automation.

Intelligent decisions

Most businesses recognise the transformational power of data, but as 'big data' has got more prominent, many of its opportunities have remained relatively untapped. There have been barriers due to the enormous number of time-consuming processes undertaken to provide the data. Within logistics, often it takes several days or even weeks to cover the whole warehouse, making the data irrelevant or out of date. This limited accuracy comes in the way of the data revealing its full potential.

Large supply chain companies today use some form of business intelligence, usually a static interpretation with limited insight capabilities. The next step is to move to a real-time data-insights company. Real-time decision intelligence makes invaluable data-driven decisions available to companies. Automation and AI are now enabling the evolution of using data with real-time decision-based intelligence.
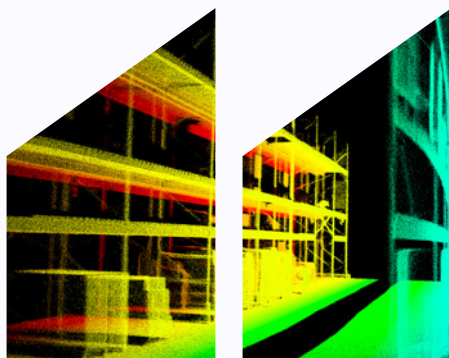
6,000 hours

Yearly, over 1 million euros are lost due to misplaced or damaged items, according to statistics, while 6,000 hours are wasted measuring and tracking goods manually.

23 minutes

Other measurements reveal that over 23 minutes per pallet are wasted retrieving lost inventory.

11%

Moreover, 11% of goods have some level of case damage on warehouse arrival.

40 hours

With autonomous label scanning, a company can save 40 hours per operator every week, which otherwise would be missed on manual processes.

IN A RECENT POLL, SUPPLY CHAIN OPERATORS WERE ASKED:

'if you had a digital twin of your warehouse, what would you use it for?'

Better stock control — **11%**

Capacity planning and forecasts — **17%**
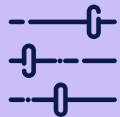
Simulation to test scenarios — **14%**

All of the above — **58%**

In practice

An integrated, real-time, data-driven 360-degree inventory management system enables businesses to gain greater visibility, improve efficiency, decrease over and under-stocking and enhance planning and purchasing. The system can also provide automated daily stock checks, which companies find they cannot perform effectively or timely manually, reducing the time and cost of collecting reliable real-time inventory data. This data supports managers in driving better business decisions and ensuring financial compliance by identifying gaps and inconsistencies as they occur.

Real-time data and the data points in inventory management

Logistics and warehousing are on the brink of becoming even more technology-driven and real-time data will be at the core of commercial success.

As supply chains have faced unprecedented challenges over the past few years, especially in the e-commerce sector, where **online sales increased to 119.64 billion GBP in 2021 from 33.24 in 2012[3]**, the need for highly efficient warehousing and inventory management has grown exponentially. The difficulty in finding the right labour and soaring overhead costs have only added to the need.

In the world of business today, company supply chains compete as much as the businesses themselves. An integrated real-time, 360-degree inventory enables companies to gain greater visibility, improve efficiency, decrease over and under-stocking and enhance planning and purchasing. A technology driven and real-time data process provides automated daily stock checks, which companies cannot perform effectively manually, reducing the time and cost of collecting reliable real-time inventory data.

This data supports managers in driving better business decisions and ensuring financial compliance by identifying gaps and inconsistencies as they occur.

Additionally, the technology reduces revenue leakage associated with lost, misplaced or non-compliant assets. Plus, warehouses that sell rack space can see what space is available at any given time, increasing revenues by better utilising their racks.

This is why integrating data-capturing robotics and data-driven AI platforms will be an essential factor for the future of warehousing, automating repetitive and highly labour-intensive activities, enabling staff to focus on critical operations, using space wisely and attracting and retaining employees.

Why capture real-time data in inventory management?

- To close the physical to digital data loop
- To reduce the cost, time inaccuracy and safety risks
- Increase productivity, efficiency and revenues
- Forecast more accurately

Digital twins in logistics and warehousing for inventory management

A digital twin provides value and insights through visualisation, analysis and prediction. A real-time digital twin creates a bridge between data from existing warehouse management systems with live data from within the warehouse.

A digital twin empowered system can alert if the data doesn't match, allowing the problem to be fixed immediately.

As a result of using this system, warehouse inventory counts can be eliminated, space can be better utilised and can reduce goods misplacement.

An integrated real-time, 360-degree inventory enables companies to gain greater visibility, improve efficiency and enhance planning and purchasing.

	EASE OF USE	OPERATION LOGIC	OPERATION SIMULATION	OPERATION PREDICTIVE DIAGNOSTICS	REAL-TIME DATA	3D VISUALISATION	OPERATION RETRO DIAGNOSIS
DIGITAL TWIN	✓	✓	✓	✓	✓	✓	✓
WMS	✓	✓	✗	✗	✗	✗	✓

Differentiation between real-time in a digital twin vs WMS

Today's Warehouse Management System (WMS) is a hub of integrations, connecting warehouse inventory to all areas of the supply chain which is accessed online and now quite often from the cloud. Combining the WMS with a digital twin offers a way to have complete operational visibility and integration of everything inside the warehouse.

The WMS only has the data as inputted, if these inputs are incorrect, the WMS will be incorrect. Hence, why a digital twin, using real-time data, brings the physical and digital together continuously. A digital twin helps errors in the WMS as soon as they happen, provided from the real-time data of the physical world.

This type of predictive model could even be used for labour planning. Suppose there is a peak season about to occur. Still, unusual demand trends have changed the amount of work coming in. How much labour should your warehouse inventory account for in the upcoming season? The AI platform would use the historical, accurate real-time data, current industry demand and other outside factors to know precisely how many workers will be needed to fulfil all orders over a specific period. This would save warehouse costs and alleviate third party logistics' (3PLs) concerns about peak season labour costs and shortages.

How Dexory is transforming Menzies Aviation operations through AI and automation solutions

Menzies Aviation is an international aviation services business with operations worldwide, bought in Dexory's AI platform and a fully autonomous mobile robot at its Heathrow cargo facility.

The need for greater visibility of inbound cargo, from understanding under-reported volumes and mis-declarations, which meant inaccurate data led to incorrect storage charges, reduced load efficiency and ultimately impact on profitability. Ability to optimise aircraft, freight and facility space was also important.

Dexory's platform was introduced to track and find goods within the facility, by scanning and photographically capturing cargo providing highly accurate, real-time data. The autonomous robot runs nightly audits for inventory checking and generating exception reports highlighting UTLs (unable to locate pallets), misplaced goods and rack occupancy levels, delivering far greater accuracy of the warehouse stock. This real-time data is compared against the data in the Warehouse management system (WMS).
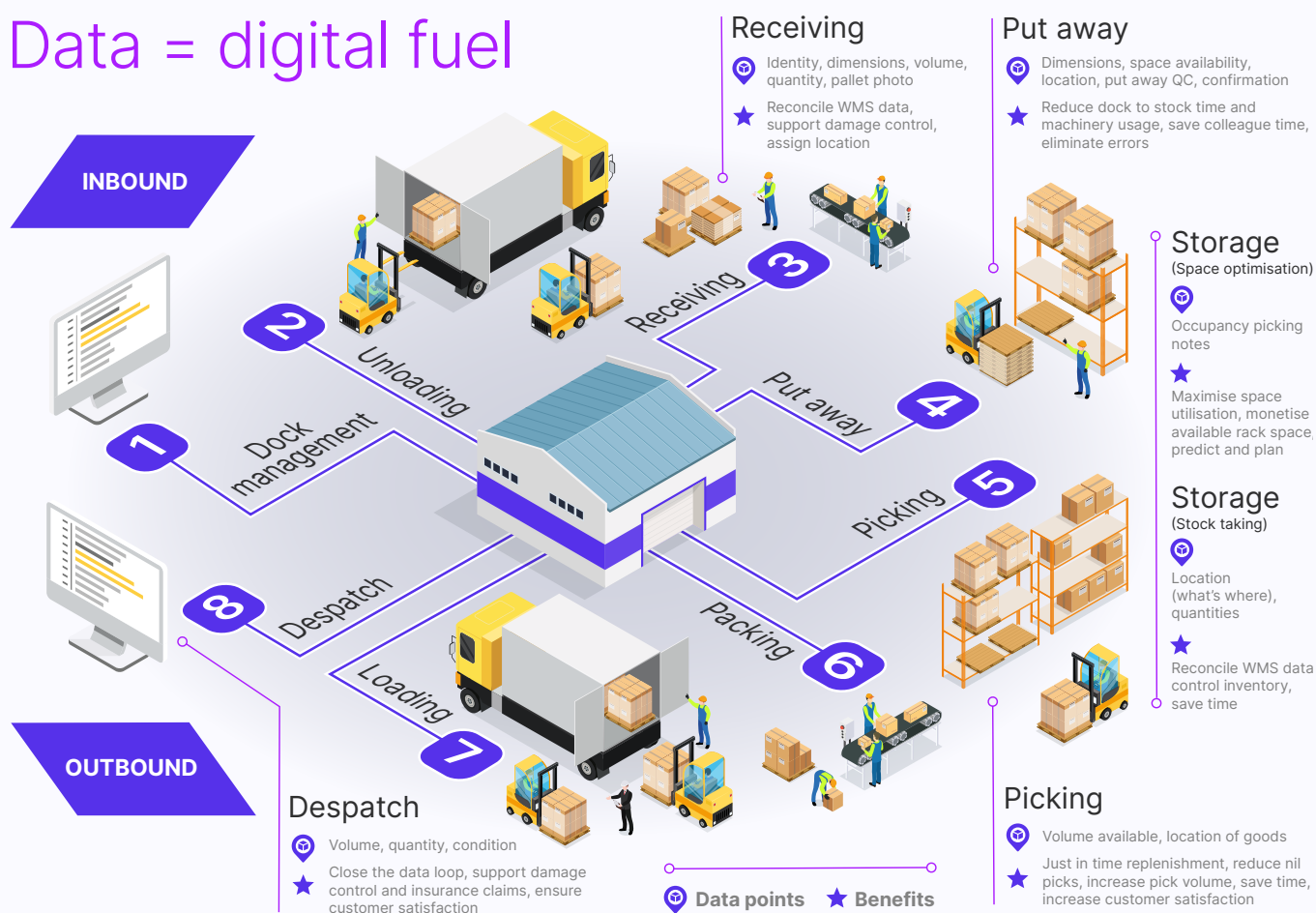
Business impact:

- More efficient operations - greater clarity on inbound and outbound loads

- Saves valuable time - tens of hours per week saved moving from manual to automated robotic perpetual checks

- Immediate financial benefits realised by reducing the number of misplaced and non-compliant assets.

"It was important for us to use the technology to add real-time value to the operation. Mimi is delivering this, as on a daily basis we are scanning over 500 locations and achieving high accuracy levels in a fraction of the time it has historically taken to do it manually".

Rory Fidler, Vice President Cargo Technology

Unlocking the power of your data

Data = digital fuel

INBOUND

OUTBOUND

Receiving
- 📍 Identity, dimensions, volume, quantity, pallet photo
- ⭐ Reconcile WMS data, support damage control, assign location

Put away
- 📍 Dimensions, space availability, location, put away QC, confirmation
- ⭐ Reduce dock to stock time and machinery usage, save colleague time, eliminate errors

Storage
(Space optimisation)
- 📍 Occupancy picking notes
- ⭐ Maximise space utilisation, monetise available rack space, predict and plan

Storage
(Stock taking)
- 📍 Location (what's where), quantities
- ⭐ Reconcile WMS data control inventory, save time

Picking
- 📍 Volume available, location of goods
- ⭐ Just in time replenishment, reduce nil picks, increase pick volume, save time, increase customer satisfaction

Despatch
- 📍 Volume, quantity, condition
- ⭐ Close the data loop, support damage control and insurance claims, ensure customer satisfaction

📍 **Data points**   ⭐ **Benefits**

1 · 2 · 3 · 4 · 5 · 6 · 7 · 8

Dock management · Unloading · Receiving · Put away · Picking · Packing · Loading · Despatch

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Alongside the day-to-day operational gains, the business intelligence available based on real-time data and a digital twin allows for more significant insights to predict, analyse and learn.

By leveraging AI-driven digital twins, customers gain a deeper understanding of their operations and can optimise their supply chain, from sourcing and planning to distribution and logistical processes.

The warehouse's advanced and predictive analytics from the digital twin system improves forecasting and drives more intelligent decision-making. With advanced analytics, businesses can accurately forecast demand,

plan inventory locations, determine stock demand value and reduce risks. Even with complex supply chains, companies can respond quickly to supply chain issues, manage complexity and demand resulting from new channels and optimise picking and storage intelligently.

You can:

- **Analyse and learn**
- **Test different scenarios before implementing them**
- **Storage analysis**
- **Map peaks and scenario planning**
- **Maximise capacity utilisation**

An artificial intelligence platform using its own big data, outside industry trends and real-time inventory information to know how fast a product moves and when to reorder it. Imagine never running out of stock because replenishment is always ordered beforehand. Never waste space in your warehouse by carrying more products than are needed. This is the core to maximising profitability by selling the right inventory whilst reducing the storage space of stagnant products.

Powered by autonomous robots, DexoryView is the only platform that delivers real-time data and insights for the receiving, storing and dispatch stages, giving companies unprecedented real-time access to their operations from anywhere and at any time.

Real-time actionable insight.
All the time.

Real-time, all the time

You need insights across your whole business operations, in real-time.

Dexory delivers by layering data and intelligence over physical environments, using the myriad of data points collected by our robots from your physical space.

They send a constant stream of insights back to the cloud, giving you seamless back-end integration.
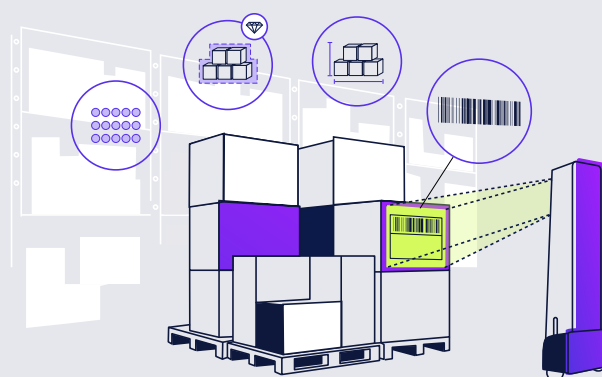
Data delivered by robots

Our autonomous robots collect real-time data on parcels, pallets and products as it passes through the warehouse, allowing for much better inventory control and condition reporting. This reduces misplacement errors, whilst ensuring that the right stock is available.

The data updates the digital twin platform.
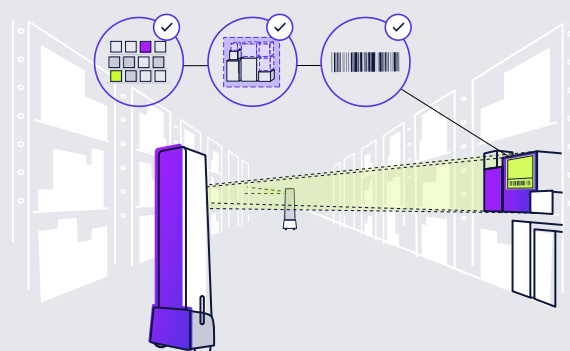
Optimise processes

The warehouse's advanced and predictive analysis from the digital twin platform improves forecasting and drives more intelligent decision making.

With advanced analytics, businesses can accurately forecasts demand, plan inventory locations, determine stock demand value, and reduce risks.

Looking to the future

Digital twins in **logistics**

In logistics, **the ultimate digital twin** would be a model of an entire supply chain network

Taking all this to the next level will be a virtual representation of a business's physical supply chain, a flow of real-time data and visualisation. This will allow companies to combine data from multiple sources and achieve a complete picture of operations, stock levels, exception planning and other information within their supply chains.

The ultimate digital twin for supply chains would be a model of the entire network, from the initial manufacturer, haulier, ports, sea and air freight movements, railway freight, warehousing/distribution centres, road networks and destination streets through to either the retail entity or the customer homes and workplaces.

We know that logistics is transforming into a truly tech industry. And the warehouse of the future will streamline its operations based on real-time data, feeding continuously into AI and automation.

Digital twins are also maturing; through the progress in IoT, big real-time data, open APIs, AI and virtual reality, the static digital model and simulation of the past are becoming alive in real-time to help optimise, predict

and forecast inventory management. They simplify the complex through autonomous technology, driving strategic thinking at all business operations levels.

Embracing data sharing through the supply chain is an important first step, to move past data segmentation. And turn the supply chain into a truly connected supply network, offering the ultimate visibility and efficiency required for growth.

As illustrated, this journey or transformation is already happening, as parts of it are achievable today. Still, the utopia of a truly connected, transparent supply chain real-time data network is likely to be a few years away from full implementation.

Conclusion

Supply chains which can self-monitor and be self-maintained by constant data exchange between suppliers, devices and logistics providers will be transformed into an intelligent predictable system.

Embracing data sharing through the supply chain is an important first step, to move past data segmentation. Real-time data fed digital twins in the supply chain turn the supply chain into a truly connected supply network, offering the ultimate visibility and efficiency required for growth and an integrated logistics industry.

Our vision is to enable companies unprecedented immediate access to their operations, Dexory's innovative technology is revolutionising warehouse and large storage area management everywhere.

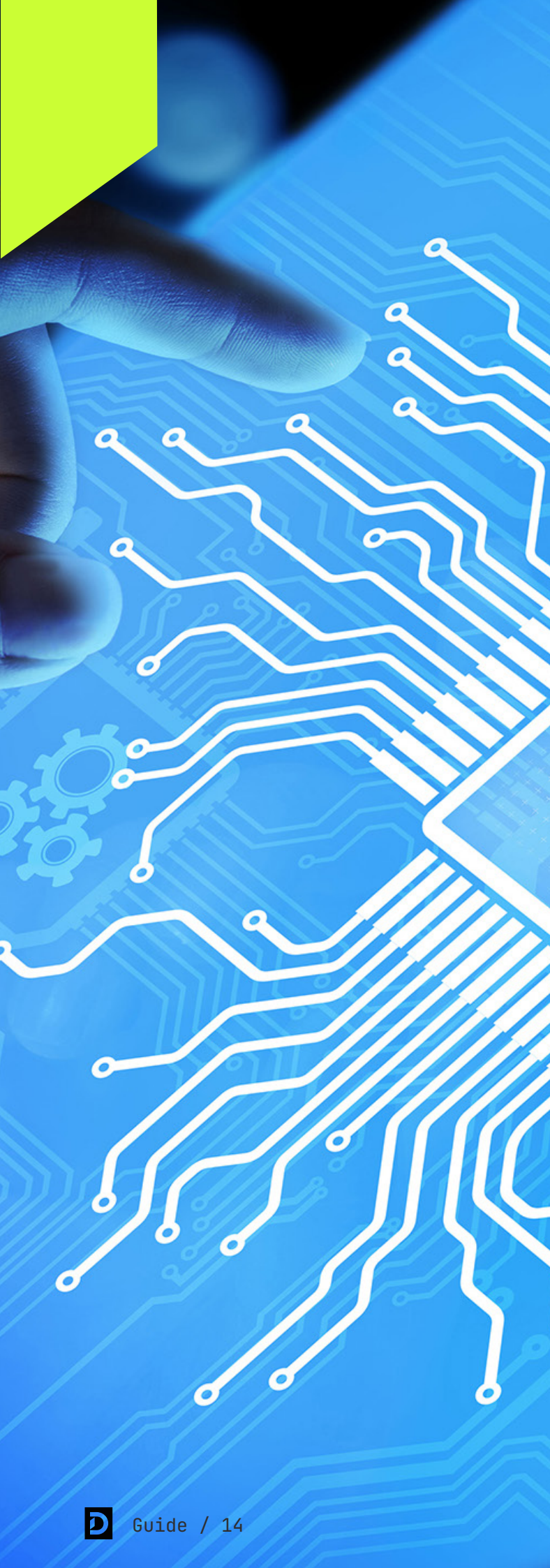## Join us in making that next step.

About Dexory

Dexory captures real-time insights of warehouse operations using fully autonomous robots and Artificial Intelligence.

We make the complex simple. Using autonomous technology to unlock data and drive insights through all levels of business operations, helping companies boost their performance and maximise their full potential.

Our fully autonomous mobile and modular robots measure, track, and find goods across warehouses without workflow disruption. The data is fed real time into digital twins, allowing logistics and warehouses to quickly respond to operational challenges they face on a daily basis.

Instant access to real time data helps optimise the present, de-risk the future and discover the intractable in each location and at every stage of the product journey through the warehouse and onto dispatch. Founded in 2015, Dexory aims to transform the data gathering operations of warehouse environments.

Terminology explained

WMS - A warehouse management system (WMS) is a software solution that offers visibility into a business's inventory and manages supply chain fulfilment operations from the warehouse/distribution centre to the end destination.

IoT (Internet of Things) refers to the collective network of connected devices and the technology that facilitates communication and data exchange between themselves and platforms or the cloud.

Cloud computing is delivering computing services including servers, storage, databases, networking, software, analytics, and intelligence over the internet ("the cloud") to offer faster innovation, flexible resources and economies of scale.

API (Application Programming Interface) is a software intermediary that allows two applications to communicate. Open-source software is a code designed to be publicly accessible anyone can see, modify and use the code as they see fit.

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