Article

Digital Twin

How Companies benefit from a Digital Twin

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Digital Twins merge digital and real world even more. Especially in the B2B Sector, there is no limit for use cases.

Since well before the Hollywood movie Avatar, the reality´s digital display is a vital part in the world of Industry 4.0. According to Gartner, companies may increase their production by 10 percent – and as a result, a majority of manufacturing companies will have installed a corresponding display within the next ten years. Enough reason to take a closer look at this topic.

Motivation and Potentials

The Digital Twin is one of Gartner's Top 10 Topics of 2017. Gartner´s assessment shouldn´t be missing while evaluating the technology´s maturity (whereas it remains to be seen if this is a single technology). According to the analysts, it may take around five years until the Digital Twin reaches its maturity.

Nevertheless, there are many projects around this topic. Regardless of the concept´s majority, nearly every German automotive manufacturer promotes the subject emphatically. Using the Digital Twin, proofing if a part can be retrofitted or is compatible to the rest of the vehicle becomes very simple and fast. Benefits are found in product development, production and in planning product recalls at after sales.

Practical Examples

Digital Twins are no longer simply a theoretical construct, even if their characteristic may differ depending on the area of application. This applies especially to the physical structure´s functional characteristics and coverage. The electronics industry is most certainly a pioneer in this area.

A fine example of a Smart Factory and thus the Digital Twin´s implementation is the Siemens facility in Amberg. It is awarded prices on a regular basis. The electronics industry is more than predestined for this topic. Due to the production´s complexity, a high level of automation is essential for many years. Ensuring high quality in circuit board mounting isn´t possible with human and thus manual work.

Further examples are port visualizations in e.g. Rotterdam or Hamburg. In these particular cases, not every detail of the port, but only those essential for the operation are replicated, so it´s sufficient to provide only a few data points. This is one of the most important aspects of the Digital Twin – its granularity. Academic completeness needs to give way for pragmatism. It makes no sense to describe and model irrelevant and for the particular demanded purpose unnecessary attributes. Only relevant data has to be processed.

At Porsche, all production steps are compared to the Digital Twin by the IT-systems in real time. By doing this, they could detect variations in quality even before customers notice. Suppliers start developing Digital Twins for their products as well. New business models quicken these approaches. Further approaches are virtual commissioning of machines and entire production lines. Unfortunately, the Digital Twin´s use in sales is neglected. With this,

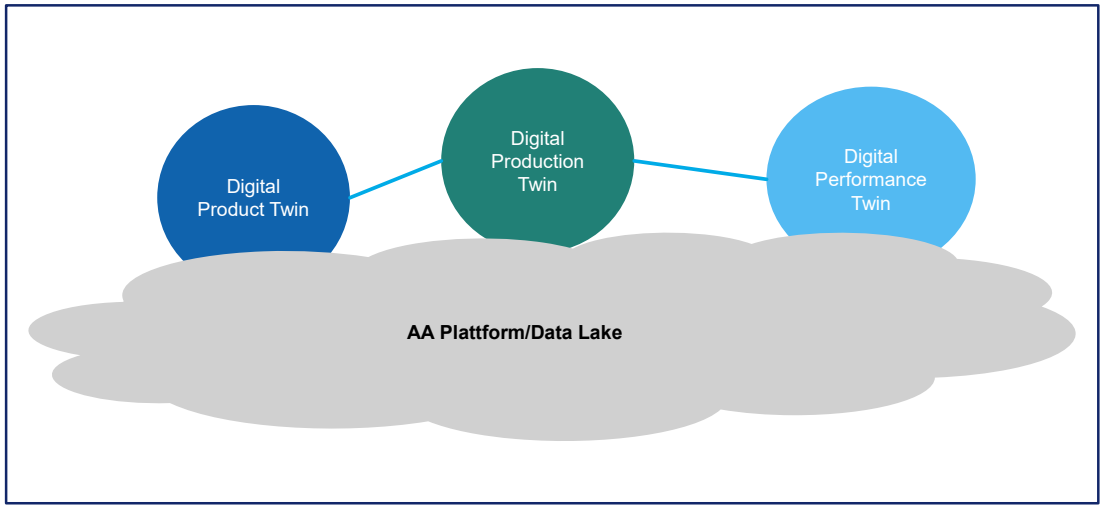
sales talk can be held more realistically and emotionally - especially for the product car. Furthermore, Virtual Reality can be used to display the special machine´s or new car´s dimensions more realistically.

Developing a Digital Twin

Let´s head to the terminology first. The Digital Twin tries to map the reality virtually – but only with the necessary granularity. A whole lot of data and information is collected, so a breakdown does make sense. Subsequently, an illustration according the Siemens-nomenclature follows. The Digital Twin is separated into:

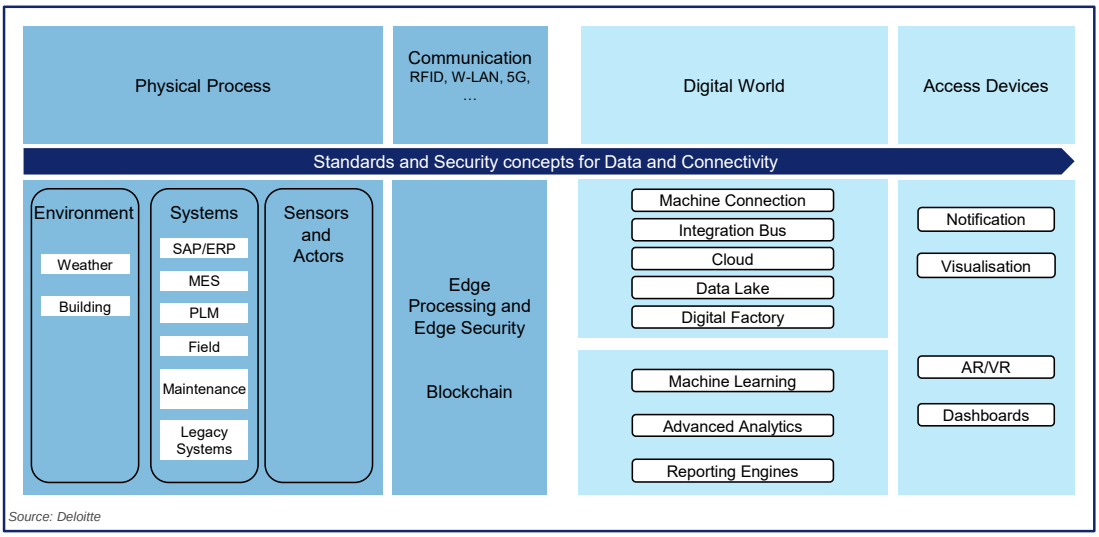
- **Digital Product Twin** (here we are located in the product development – product with 3D-Modell/CAD-Modell, test criteria, necessary simulations during product development, …)
- **Digital Production Twin** (now we have reached the factory planning – machines and plants, instruments, NC-programs and test programs for manufacturing our product)
- **Digital Processing Twin** also referred to as the product´s memory (finally we can start producing our products, here production KPIs and data like throughput time, complying with deadlines, quality etc. are aspects to consider)

Data Lake and Advanced-Analytics cumulate the data. Various solution providers strive for bringing „their“ IIoT-Platform as cloud approach in position, but this is by no means necessary. Besides, we will head to the individual suppliers shortly, but first we look at something fundamental.



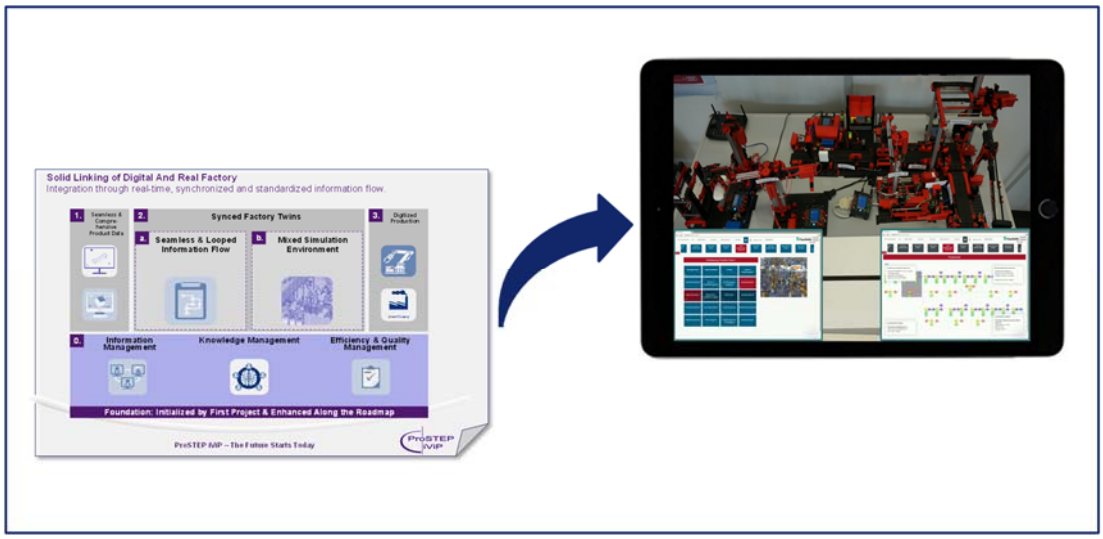
The Digital Twin´s place in the (I)IoT-Landscape

As already mentioned, the Digital twin is about collecting the relevant data of a product and its environment. So it´s no surprise that the data comes from the leading systems, the PLM for product development, the digital factory for production planning, the ERP for business concerns and finally MES for the production. The field information, when the product is “in action” with the customer and runs flawless and thus free of failure, shouldn´t be neglected of course. This leads almost inevitable to the Digital Twin´s architecture.



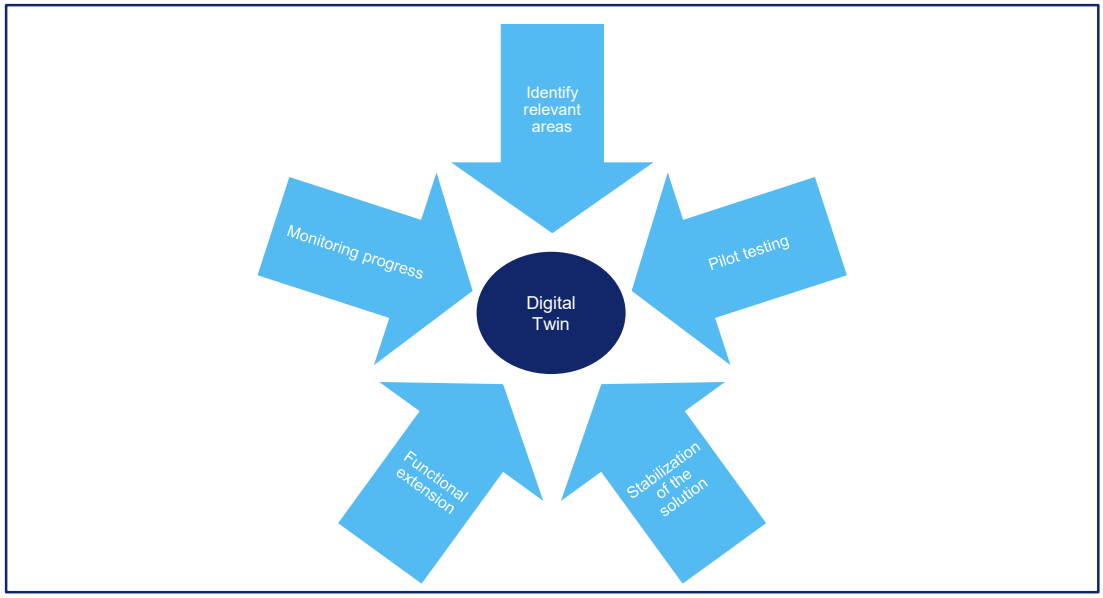
The Digital Twins architecture

It becomes quickly apparent that massive substantial integration problems incl. Master Data Management occur. Therefore, it may not surprise that a uniform description language is necessary to master the heterogeneity. Thus, there is a lot to do when trying to implement a Digital Twin.



Modeling a Digital Twin

Of course, there has to be a methodical approach. Deloitte have made their own thoughts on this topic, additionally, one can fall back to the later mentioned manufacturer´s approaches. The important thing is that the digital twin is built agile, i.e. step by step. Specific use cases help to ensure acceptance in the respective departments. The benefits and thus the advantages are also quickly made clear to the management.



Procedure for the implementation of a digital twin

Digital Twin – Product vendors and their solutions

The vendors are essentially divided into the group of PLM- and cloud service providers. All relevant PLM-vendors pursue independent and differentiated strategies. Siemens provides the most comprehensive one. Of course, there is also SAP. Overall, the following providers are involved, although the selection was certainly somewhat subjective:

PLM-vendors

- Siemens
- PTC
- Dassault

Cloud and software vendors

- IBM
- Microsoft
- SAP

Industry companies

- General Electric (GE)

The individual providers are briefly introduced below. What all approaches have in common is that the data will eventually end in the respective vendor´s cloud. This attempts to create a digital ecosystem – of course the one of the provider with all its consequences. As a result, all companies are setting up a corresponding IIoT platform.

Siemens

It shouldn´t be a surprise that Siemens has the most comprehensive solution portfolio. This relates not only functional building blocks, but also the industries. In the beginning of the article, the electronics plant in Amberg was already mentioned. Siemens uses MindSphere not exclusively as a cloud solution for customers. It also serves as a integration platform for the multitude of required solutions, not only around the digital twin, but also at the digital factory´s implementation.

The solutions´ degree of maturity is of course also dependent on the respective industry and therefore different. MindSphere was introduced at the Hanover Fair in 2017. It is therefore still in development. In terms of time, the company is thus lagging behind its biggest competitor GE.

The individual solution blocks, such as PLM (Teamcenter), MES (SIMATIC IT) etc. provide more or less existing standard interfaces. In practice, however, it is necessary to adapt these on the respective needs (among other things in direction of the ERP system, i.e. mostly SAP). By no means should this effort be underestimated. However, this applies to all providers. Well-known companies such as Volkswagen rely, among other things, on Siemens´ solutions. Unfortunately, the MES solution has weaknesses.

Currently, no machine connection via OPC-UA is planned. In the future, this will probably happen via the cloud platform. Furthermore, the customizing efforts must not be underestimated. The latest S7-1500 PLCs have a built-in OPC-UA server. This allows an easy integration into the MindSphere Cloud.

Dassault

It should come as no surprise that Dassault Systems, as one of the leading provider of PLM systems, focuses on product development, i.e. on product twins. The French company also uses Augmented Reality to visualize new products in use. Thus, the “digital journey” starts with the CAD and 3D model. Dassault offers SaaS solutions (Software as a Service) to offer customers a quick and cost-effective start.

Similar to Siemens, integration into production is at the top of the agenda for the French company. With Apriso Dassault has also incorporated an MES. Similar to Siemens, a solution portfolio for the entire production area is being built up here. In total, the offered solutions are comparable to those of Siemens – but slightly behind the Munich-based company.

PTC

In contrast to the two “big” PLM vendors Dassault and Siemens, PTC focuses very strongly on product development. Similar to its competitors, PTC has built up an IoT platform. Big Data solutions are just as much a part of the portfolio as supporting users – for example via Augmented Reality solutions. Big Data solutions and the company´s own IoT platform allow insights from product use. Sensors can be connected via the platform.

Since 2013, PTC cooperates with GE to close the gap regarding MES development. The partnership benefits both sides. GE has its own gaps in the area of PLM. Both system worlds are integrated accordingly. As with all other providers, we have to let go of standard interfaces. Of course, the respective manufacturers offer these. In practice, however, they do not keep their promises, which is associated with corresponding adjustments and thus costs. Unfortunately, the interface issue has not become obsolete due to the digital twin. In general, an integration of the individual system worlds is preferable.

IBM

IBM is entering the race around the digital twin with “Cognitive Digital Twin”. Essentially, this is an appropriate integration framework. The comments regarding the structure of a digital twin have hopefully shown that data sources lie in the leading systems ERP, PLM and MES. Therefore, an appropriate integration service is required for the implementation. This is where IBM comes in. This includes corresponding connected services up to sensors.

Another important point, of course, is the use of the data via corresponding Advanced Analytics approaches. This is where “Big Blue” can show its full strength in combination with cloud approaches. To what extent IBM´s references are “real” digital twin projects or “only” advanced analytics references is of secondary importance at the end of the day. Big Data technology is the digital twin´s “brain”. In total, the company offers a partial aspect of the digital twin.

Microsoft

Microsoft´s strategy is similar to IBM´s. At the end of the day, both companies are software providers, which of course is reflected in their solutions. The Redmond-based company also offers comprehensive Advanced Analytics solutions. Microsoft also presented a showcase at the Hanover Fair 2017. Here, the focus was also on production. Especially the topics vertical and horizontal integration are addressed.

In addition, the company is also moving in the direction towards the Production Twin – the digital image of the building. Of course, the topic cloud should not be missing at Microsoft either. All solutions are available via the Azure cloud. Another topic at Microsoft is Advanced Analytics. Parallel to the other IT companies, Microsoft is intensively building a digital eco-system.

SAP

SAP offers a wide range of solution around the digital twin. One of the “youngest children” is BIM (Building Information System), also a digital twin for building management. SAP tries, among other things, to develop industry- and topic-specific solutions and to combine them with cross-industry solutions. The Digital Twin for this sector includes, among other things, their PLM, Asset Management and Connected Manufacturing. This puts the company in a position to establish heavyweight solutions quickly and functionally. This is also in line with SAP´s general strategy, which is to create benefit for the customer.

As BIM is still very young, it remains to be seen how the market, i.e. the customers, will react to it. The example shows also the heterogeneity of solutions and problems. Facility management, ports and car manufacturers are just a few examples for the use of the digital twin. As different as the questions are, as different and comprehensive are the respective solutions.

Let´s stick to the example of BIM. The entire life cycle of a building, i.e. from planning to maintenance (facility management), is mapped here. Using the cloud-based approach, all process participants are able to communicate and exchange information efficiently. Furthermore, it is ensured, that the data is up-to-date and complete. Due to the longevity of the “products”, i.e. the buildings, future security plays a very important role. This is ensured by the use of appropriate standards.

General Electric

GE started addressing the topic a few years ago with its cloud-based Predix solution. The digital transformation of companies is therefore GE´s top priority. The quote of former CEO Jeffrey Immelt – “If you went to bed last night as an industrial company, you're going to wake up today as a software and analytics company” – is more than just a slogan here. The American industrial giant´s claim is comparable to that of Siemens – and of course their self-conception, too. Therefore, it should not come as a surprise that GE is the biggest competitor of Siemens. Due to its long history, the IIoT Platform has a corresponding range of functions.

Through the cooperation with PTC (see description of PTC), the gap regarding PLM could be closed quickly and with an established vendor. Thus, a complete solution from engineering to production can be represented. The company´s own MES is responsible for controlling monitoring production. Regardless of the respective product maturity, a considerable adjustment effort is to be expected, when introducing such systems. The machines to be connected are too different. OPC-UA promises a solution here, but is supported by the very few vendors.

Conclusion and Summary

Implementing a digital twin is a complex and extensive effort. The aim is to integrate all core business processes from product development and production to sales and after-sales in order to obtain a complete picture of reality. On the other hand, it is important to warn against full academic solutions. The business benefit should be the driving force. Thus, it´s necessary to build up the digital twin step by step, i.e. agile. Here first benefits can be shown in concrete terms and the complexity is also much easier to control.

In general, a vertical and horizontal integration in combination with Big Data and Advanced Analytics must be implemented in the project. Projects like these have already been extremely challenging years ago and won´t get easier due to the digital twin. The organization's transformation must not be ignored for the sake of technological considerations. It is, however, a key element. It is a matter of getting the people on board, because, in the end of the day, they have to use the new systems - including the digital twin.

The Company

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