25 YEARS OF IES

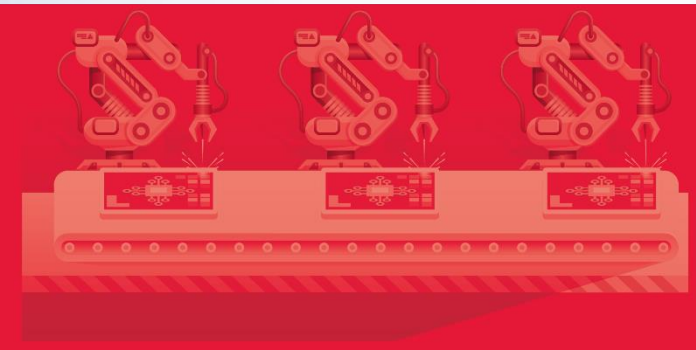
ptc | Tech Mahindra

DT = [DT]²

DIGITAL TRANSFORMATION = DIGITAL TWIN X DIGITAL THREAD

Bengaluru | India | 2020

Connected World.
Connected Experiences.



THE VOICE OF EXPERTS

High cost of factory downtime

The global automobile industry loses an average $22,000 per minute due to unexpected stoppage of production.

IIoT World[1]

Benefits of cross functional collaboration

As organizations foster functional collaboration, they would be able to achieve 44% reduction in downtime and 12% operational improvement.

McKinsey & Co[2]

Value of data in manufacturing

By sharing data, companies can generate additional value of US$ 100 bn.

World Economic Forum[3]

Adoption of digital by the enterprise

Enterprises should create a team to drive the architecture and the data policies for digital twins.

Gartner Inc[4]

Source

1. https://iiot-world.com/connected-industry/the-cost-of-one-minute-downtime-in-manufacturing/
2. “Global light-house network”, January 2020
3. “Share to Gain”, WEF research, January 2020
4. Webinar on “Digital Twins: The Future of Better IoT Fueled Business Decisions”, Slide no 24

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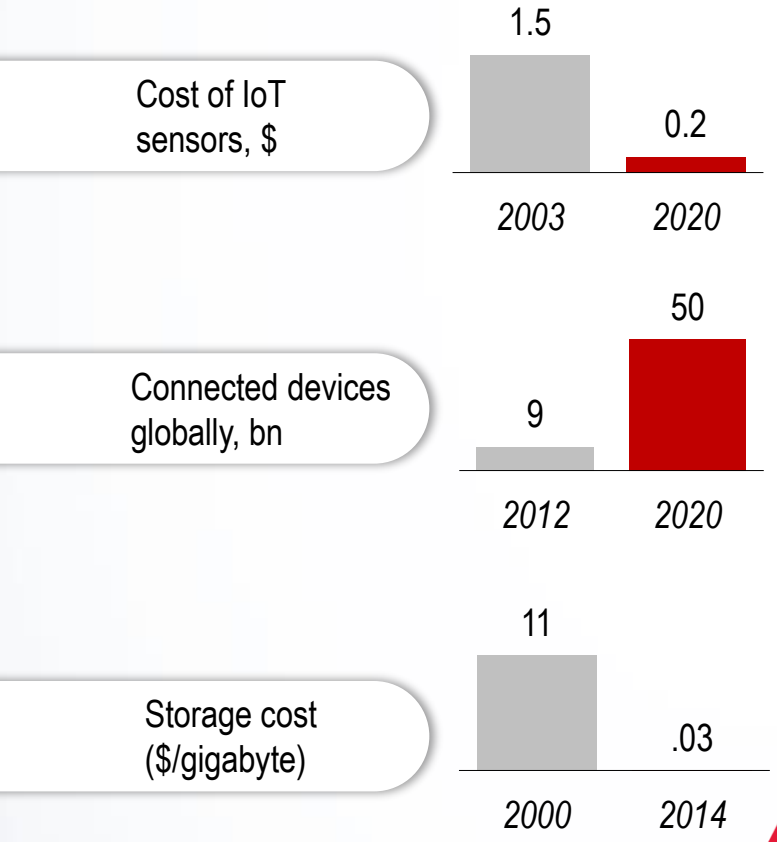
VISION OF A TRULY INTEGRATED OPERATION

Asset heavy industries pursue a dual goal to reduce the cash burn-rate of their resources on one hand and to enhance the cash-generating capabilities on the other. This dream had hitherto remained elusive due to a mismatch between strategy and technology, the prohibitive cost, and lagging maturity of the available technologies.

Mainstream adoption of MES, cloud and more recently has significantly accelerated many organizations' journey towards digital transformation. Their collective impact on the enterprises has been profound, to say to the least. At the same time, progressive reduction in the cost of enabling technologies such as IoT and connectivity have also had an overall positive impact.

Enabling conditions for adoption of digital by the enterprises



Data Source:
Inside the Internet of Things,
Deloitte University Press

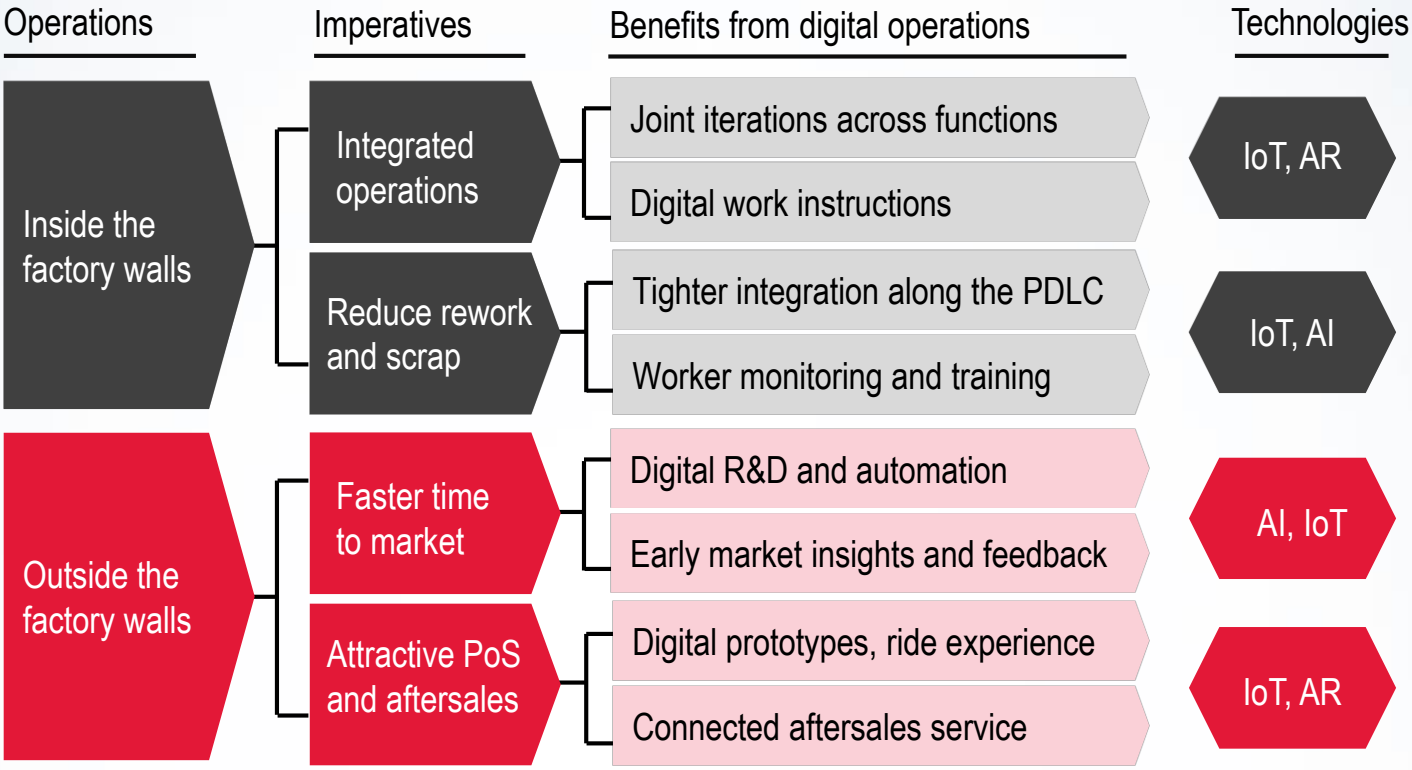
DIGITAL TRANSFORMATION = DIGITAL TWIN X DIGITAL THREAD

Digital Transformation in a manufacturing context is generally well understood by the community. That said, the terms Digital Twin and Digital Thread are being expressed differently by different industries, technologists, and service providers. For the purpose of this paper, let us describe these terms as follows.

- A **digital twin** is the digital model of a physical product that combines the digital product definition and physical experiences for new insights. Using different sensors attached to the physical product, the digital twin captures the condition/performance of the product. Thus, a digital Avatar (a twin or proxy) emerges that can monitor the product in real-time. Advanced analytics embedded on the digital twins can predict the future performance of the product by extrapolating the historical data captured by the sensors.

- A **digital thread** is the connection synchronizing related upstream and downstream information for data that can be connected across strategic enterprise systems e.g. PLM, ERP, CRM, IoT. The digital thread establishes a communication framework to orchestrate bidirectional data flow across the product lifecycle by breaking down the silos that traditionally prevented data being ubiquitous. To use an analogy, if the digital twin is a train in a subway, the digital thread is a subway system of rails, traffic and routing controls, etc.

FORCE MULTIPLIERS OF DIGITAL TRANSFORMATION



Digital is a new source of competitive advantage

Digital transformation is a hard-fought battle for the manufacturers. They have to wage war on several fronts to eliminate radical elements both within and outside of the four walls of the factory, such as quality issues, delays, slippages, bottlenecks, warehousing, R&D, dispatch, aftersales etc. Amidst all these, digital twins and digital threads have emerged as silver bullets. Together, they represent a significant advantage for the organization.

Note that, DT ≠ [DT]+[DT], rather, DT = [DT]2

From the perspective of technical effectiveness, the two concepts of digital twin and digital thread are complementary to each other. Their impact on a transformation initiative is multiplicative, not merely additive. If one of them is null and void, the overall effect of transformation won't amount to much.

Organizations that choose one over the other may remain at a disadvantage compared to the organization that takes an end- to- end view.

Digital enablement across industries

Physical product/process

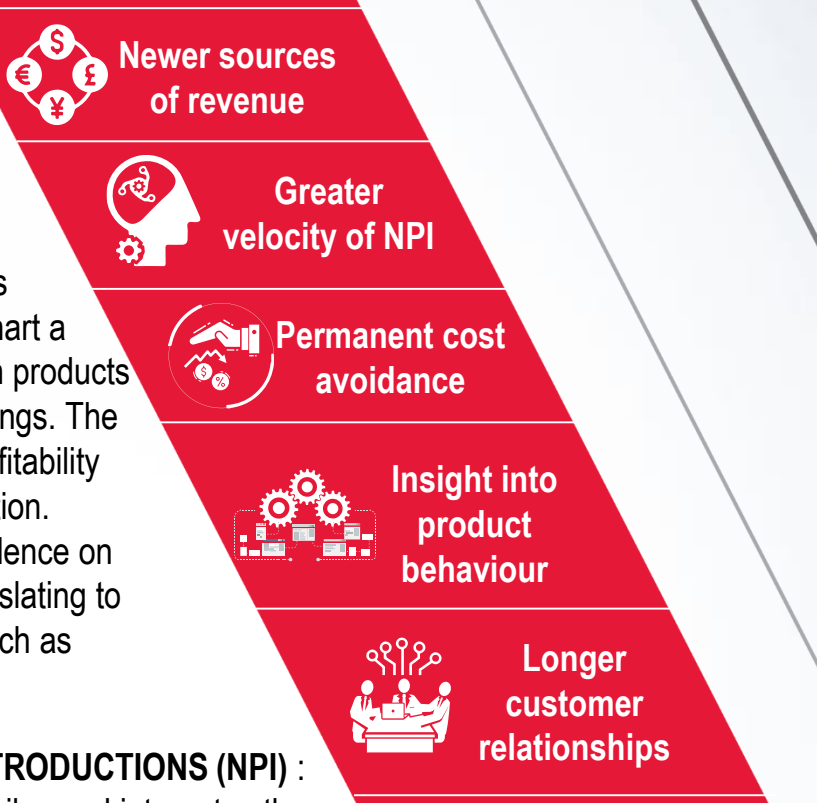
1. Car assembly
2. Metropolitan area
3. Consumer appliances
4. Medical device
5. Industrial robots

Benefit from digital enablement

1. Detection of part fitment issues
2. Monitoring of citizen services
3. Device performance monitoring
4. Remote monitoring of the patient
5. Operation control

Performance improvement

FIVE STRATEGIC IMPLICATIONS OF DIGITAL TWIN AND DIGITAL THREAD



1. **NEWER SOURCES OF REVENUE**: Digital twins are foundations from which organizations can chart a progressive journey into a new world where both products and services co-exist as a company's core offerings. The implication of such a hybrid model is greater profitability and long-term revenue visibility for the organization. Secondly, service centricity leads to less dependence on hardware/fixed assets to generate revenue, translating to improvement in key performance parameters such as Return on Assets (RoA).

2. **GREATER VELOCITY OF NEW PRODUCT INTRODUCTIONS (NPI)** : A digital thread breaks down the organizational silos and integrates the upstream and downstream processes. This eliminates any discontinuity in the NPI process and accelerates the PDLC process. For example, thanks to digital communication, Engineering Change Notices (ECNs) become visible to the production processes instantaneously, allowing the production team to undertake timely adjustments in the manufacturing process and save critical time.

3. **PERMANENT COST AVOIDANCE**: Integration brought in by the digital thread eliminates the need for a physical prototype, one of the primary cost drivers of a typical R&D process. Physical prototypes become virtual in a digital scenario. The Virtual Prototype Build (VPB) helps manufacturers save the associated cost. Similarly, digital exchange of information between the OEM and Tier-I suppliers leads to a better outcome and price discovery.

4. **DEEPER INSIGHTS INTO PRODUCT BEHAVIOR IN THE FIELD:** Digital twin establishes a post-sales relationship with the customer. It extends the management ability to monitor the product/asset In the field, enhance uptime, and improve service response. While doing so, the manufacturer gets a ringside view of the usage patterns of the product, which serves valuable insights for product line extension or new product introductions.

5. **EXTENDS MANUFACTURER'S RELATIONSHIP WITH THE CUSTOMER**: Connected products powered by its digital twin establishes long term product relationship with the manufacturer even long after they are sold. As a result, the manufacturer remains in tune with the customer through the remaining useful life of the product.

IoT IS THE BACKBONE FOR DIGITAL TWIN

The Digital Twin market is forecasted to be $16 bn by 2023, and analysts agree that IoT will be a cornerstone of this growth. IDC expects that 30% of Global 2000 companies will be using data from the digital twins of IoT connected products and assets.

DIGITAL TWINS OF A PRODUCT

Smart connected products are replacing assumptions with facts; real world IIoT data and product usage data create a feedback loop, which then informs future iterations– and even business model changes, including product-as-a service. Product telemetry also gives engineers and product designers behavioral characteristics of deployed products or even fleet of products.

DIGITAL TWIN OF A PROCESS

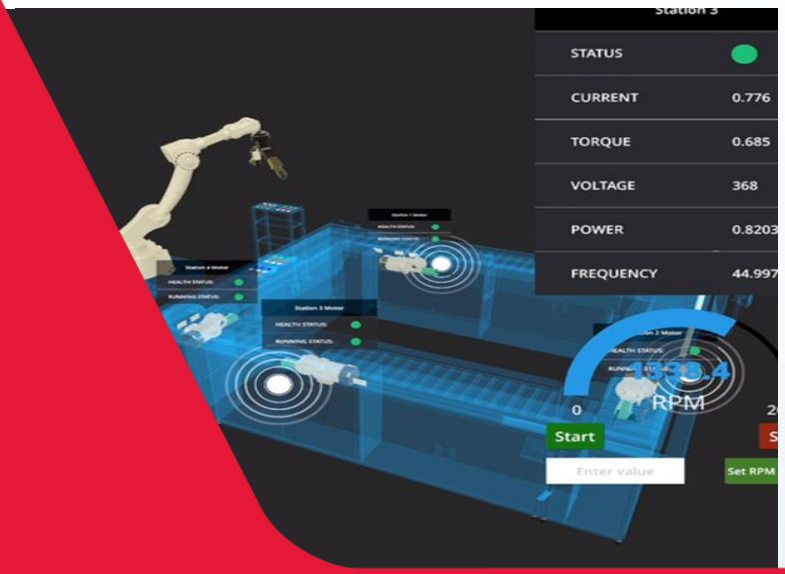
IIoT through a process lens can drive critical manufacturing KPIs. For example, improving the uptime of a single asset on a factory floor through IIoT driven predictive insights can drastically improve throughput, while a digital twin of a production line can reduce bottlenecks through enhanced operational visibility.

DIGITAL TWIN OF SERVICES

Much of a product's operational condition and performance in the end user's environment hasn't been accessible to the manufacturer or customer. With maintenance and service being critical functions to reduce asset downtime and differentiate offerings, Digital Twins can drastically improve visibility into operating conditions and product performance.

Source: "Why IoT is the backbone for Digital Twin", PTC

Illustration: Digital twin of a factory conveyor



Source: *Factory of the Future lab, Tech Mahindra*

DIGITAL THREAD IS HELPING MANUFACTURERS REDEFINE THEIR R&D AND INNOVATION ECOSYSTEM

In response to the mega trends and opportunities, the global manufacturers are redesigning their market access models, operating systems, internal processes and innovation processes. While the external collaborators jointly undertake some of these activities, the OEM takes ownership of the end to end digital thread. The manufacturing ecosystem gets more efficient as a result of such collaboration.

The enterprise systems provide a base to establish digital continuity. Digital thread plays a key role to tie all heterogenous systems together.

Visibility of data is the backbone of a multi system orchestration

Customer Service

- CRM/ERP/DMS/FSM – Service orders
- Warranty and service contract claims
- Product Cloud – fielded product telemetry

Customer Operations

- EAM/MRO – As-maintained configurations and history
- Product Cloud – fleet telemetry

Corporate

- **ERP** – Item master, Inventory

Engineering

- CAD – 2D and 3D designs
- PLM – BOM & configuration management
- ALM – Software lifecycle, requirements
- CAE – Simulation, behavioral modeling
- MBSE – Model-based requirements and product structures
- Tech Pubs – service procedures and parts catalogs
- Retail – Product line, seasons, supply chain

Manufacturing & Supply Chain

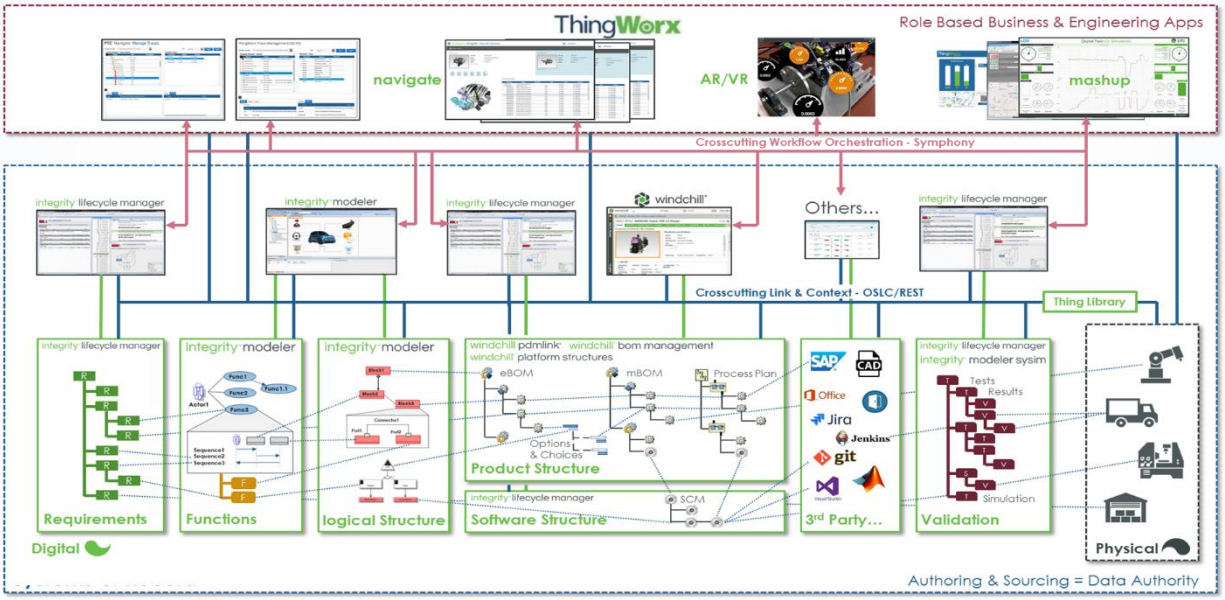
- MES – Factory invoice and assembly detail
- Sensor Gateway – Production process
- Historian – Production event timeline
- SCADA – Gathering and analyzing real-time data

Sales & Marketing

- CRM – Sales invoices for products
- Enterprise Product Costing – BOM costs

Source: PTC

DIGITAL PRODUCT TRACEABILITY



Source: PTC

PLM is one of many strategic enterprise systems, each of which provides digital continuity in their domain. To tie these heterogenous systems together in support of digital transformation is the digital thread. The digital thread is inclusive of connected data from machines and fielded products as well as the supply chain.

Fully integrated digital thread

Role and task based applications	thingworx vuforia (Navigate, Digital Twin, Digital Manufacturing, Service Optimization, Sales and Marketing, Engineering Excellence) Marketplace Tech Mahindra
Platforms	**Contextualize – Synthesize – Orchestration - Engage** Powered by: thingworx vuforia kepware
Strategic enterprise systems	PLM windchill · ERP MES MRO · CRM · DEVICE CLOUD
Data sources	CAD · BOM · TEST · MFG · SUPPLIERS · PRODUCTS

INDUSTRY BEST PRACTICES

Tech Mahindra has been working at the intersection of OT and IT layers for over two decades. While working closely with the enterprises' journey to digital transformation, it has been observed that some organizations can seamlessly integrate digital technologies into their businesses. In contrast, others tend to have a bumpy ride. Clearly, the innovators approach the process of digitalization differently with clear goals set at the beginning of the journey. Overall, their approach to four organizational constituents acts as determinant of success.

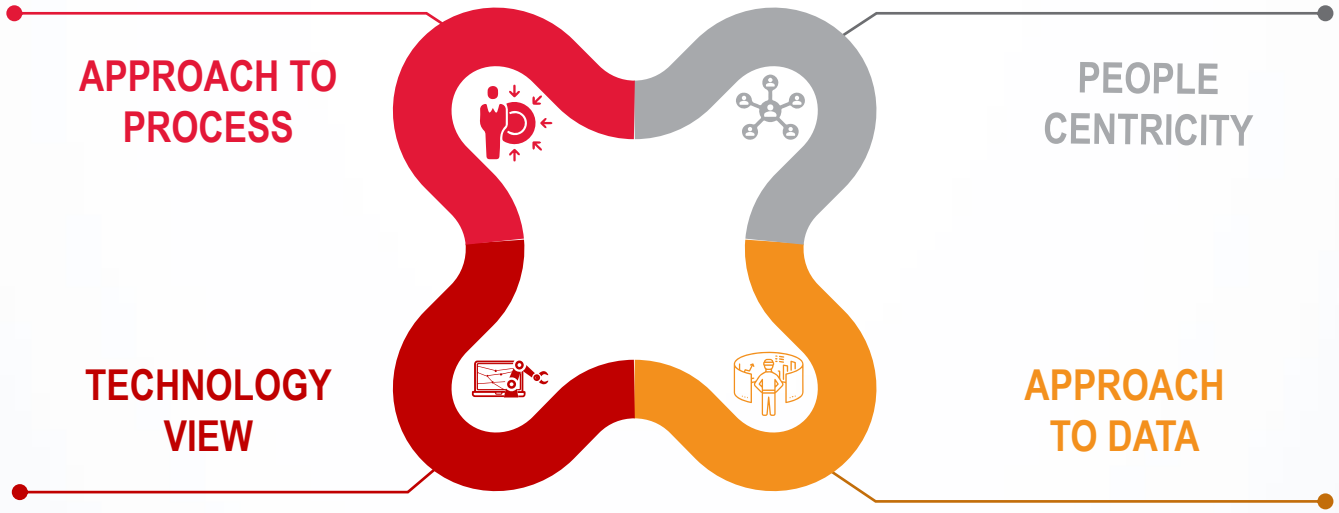
Four attributes of a successful implementation of digital twins / thread programs across industries

APPROACH TO PROCESS

1. Successful companies **avoid a piecemeal approach;** rather they adopt an end to end view.
2. Proper documentation for **knowledge transfer (KT)** for users is undertaken to understand the working of digital assets/processes.

PEOPLE CENTRICITY

1. Early involvement of client stakeholders and buy-in.
2. Design of digital twin or threads is done against a defined need to enhance the stakeholders' experience across the business process.



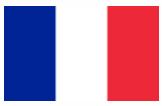
TECHNOLOGY VIEW

1. **Standardization of modeling** is undertaken for faster industrialization
2. A scale deployment / **industrialization framework** is kept ready during the PoC stage itself.
3. Avoidance of **proprietary software** as far as possible

APPROACH TO DATA

1. Gathering of insights from data and supplying them into the **strategy feedback loop.**
2. As much data capture as possible from **multiple sources** and formats is encouraged.

CASE STUDIES

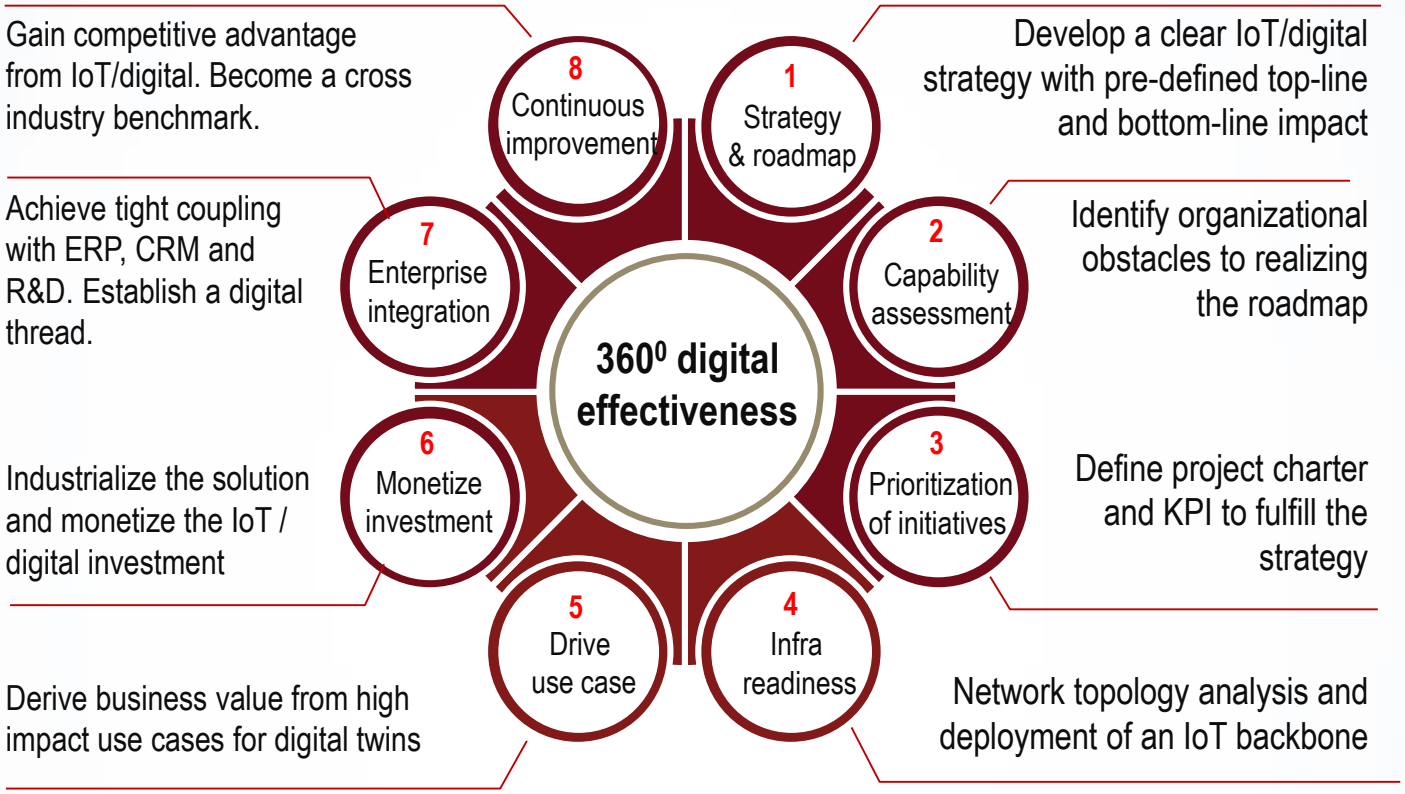
Client Profile	Client region	Solution delivered by Tech Mahindra	Benefits delivered
Leading Tier-I supplier to the aerospace industry		Collaboration platform integrating MES, ERP, Project & requirement mgmt. tools, design & validation tools and quality mgmt. tools	Reduction of development lead time, effort and scrap
Leading global defense manufacturer		Deployment of software to enable process capabilities and end-to-end digital continuity (PLM, ERP, MES, QM, EAM, IIoT)	Centralization, Reduction of interfaces, facilitation of digital continuity
European Auto OEM		Engineering-IT Platform to change legacy monoliths to modern microservice architectures	Cross-linking and traceability of business artifacts
Leading industrial motors manufacturer		Collaboration platform integrating MES, ERP, Project & requirement mgmt. tools, design & validation tools	Reduction of: ▪ Lead time ▪ Scrap
Fortune 500 retail and consumer goods major		2D/3D simulation, sensitivity analysis and layout design, allocation for robots v/s conveyor , varying SKU per line, infeed rate, varying MTTR	Reduction of: ▪ Process variation ▪ Scrap
Leading roofing systems manufacturer		Connect and collect the data from PLCs, configure historian and store the data, real-time operational intelligence	Reduction of: ▪ Process variation ▪ Scrap
Global top 10 pharma company		Monitor process parameter to improve product quality, Optimal setting suggestions	Reduction of: ▪ Cost of quality
Leading automotive OEM		Real time data capturing from field, design conformance analysis of product & sub component level details	Reduction of: ▪ Down time ▪ Cost of repair

Digital thread examples Digital twin examples

KEY TAKEAWAY

GO THE FULL DISTANCE IN YOUR DIGITAL JOURNEY WITH US

Develop deep technologies faster by leveraging Tech Mahindra's in-house capabilities, technology providers and start up ecosystem.



TECH MAHINDRA HAS AN UNMATCHED PEDIGREE OF DIGITAL TECHNOLOGY SERVICES WITH DEEP EXPERTISE IN MANUFACTURING AND ASSOCIATED VERTICALS.

Analyst recognition for Tech Mahindra in IoT and Digital Technologies

Forbes DIGITAL 100 2018	The only non-American firm to feature among the Top 15 companies in the Forbes Digital 100 List
zinnov	Overall Leader –Engineering (last 6 years), Digital & IOT Zones (last 3 years)
ISG	Leader in Overall IoT Services in Provider Lens – IoT and Engineering

AUTHORS

MARK TABER
Vice President
Mtaber@ptc.com

GOWTHAMAN SWARNAM
Head, Digital Solutions
Gowthaman.S@TechMahindra.com

KAMAKSHYA PRUSTI
Practice Head, IoT Ecosystem & Alliances
Kamakshya.prusti@TechMahindra.com

SHIREESH H
Subject Matter Expert –
Engineering and analysis
Shireesh.H@TechMahindra.com

Digital.alliance@techmahindra.com
www.techmahindra.com

ptc | Tech Mahindra