Transforming Real-World Operations with AI and AR/VR

Leveraging AI-driven AR/VR solutions to scale next-generation experiences across industries

Author
Ganesh P

Table of Contents

Table of Contents

Executive Summary

Physical AI and AI-led AR/VR are converging across manufacturing, mining, defense, and logistics, moving robots and immersive tools from isolated pilots into connected operating systems. Standalone pilots deliver limited value; the real opportunity lies in bringing seven capabilities, from autonomous robotics to safety governance, into one coordinated model. Governance cannot be retrofitted once autonomous systems are deployed at scale. Tech Mahindra's seven-tower model brings these capabilities into a single operating system, built for organizations ready to move beyond isolated pilots.

Introduction

AI-led AR/VR solutions are transforming immersive experiences into intelligent, adaptive environments that can learn, respond, and evolve in real time. They are opening up new avenues across industries by moving digital intelligence closer to human interactions.

Physical AI takes this transformation one step further by weaving intelligence into real-world environments so machines, systems, and operations can sense, analyze, and act in real time. Together, as spatial computing, they move digital intelligence off the screen and into daily workflows, field operations, and mission-critical environments.

For operations leaders across manufacturing, mining, defense, and logistics, the convergence of AI, automation, and immersive technologies provides a pathway to build smarter, safer, and more connected ecosystems. A multi-tower transformation model brings technology, workforce, and processes into a unified operating model for large organizations in industrial, field, and critical environments.

How it Changes Real-World Operations

That loop starts at the edge: sensors continuously capture real-world signals, AI interprets them, and AR/VR guides the next action for a human or robot. This creates a self-sustaining loop across manufacturing floors, field sites, and mission-critical environments alike.

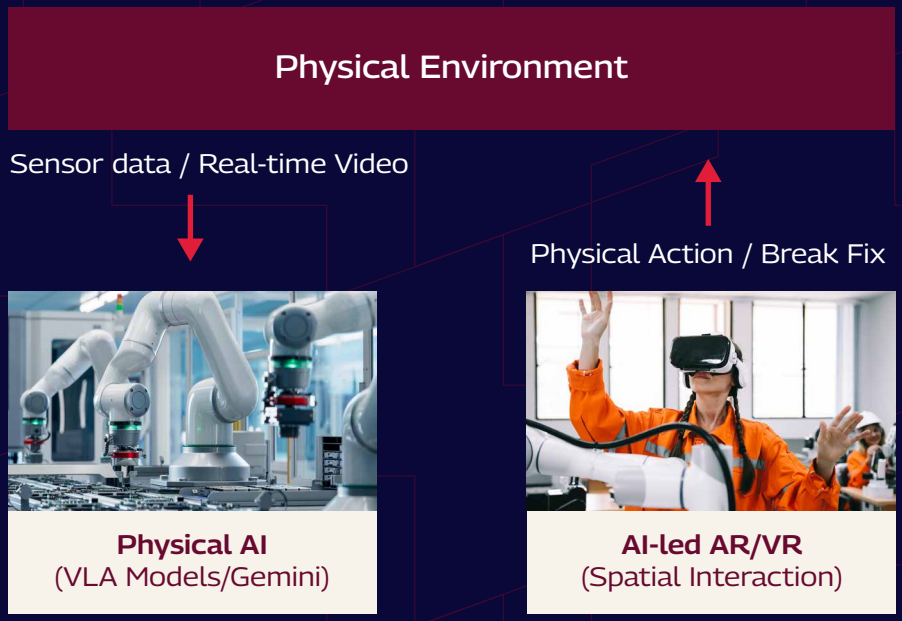


Figure 1: A Detailed Chart of the Physical Environment

Smart Manufacturing and Utilities Industrial Environments

Modern industrial plants are moving from rigid, pre-programmed automation to intelligent, adaptive environments. By merging spatial intelligence with real-time decision-making, operators can reduce manual friction, reduce downtime, and drive floor-level efficiency. Two capabilities make this possible:

Vision-Language-Action (VLA) Robots:
Traditional industrial environments depend on pre-programmed robots. VLA robots respond to natural language and adjust to varied conditions in real time to manage factory-floor requests seamlessly.

Generative AI Digital Twins:
Digital twins provide real-time, 3D views of the environment, allowing engineers to observe system behavior in real time. Using mixed reality headsets to view live data on physical equipment helps engineers diagnose issues faster and reduces manual labor.

Logistics and Infrastructure Field Operations

Field operations shift from reactive maintenance to real-time, spatial execution on the ground. By pairing connected workers with autonomous fleet systems, organizations improve uptime and streamline site-level workflows:

Context-aware Spatial Assistance:
Field technicians wearing smart glasses can capture live visual feeds from wind turbines or telecom towers. These inputs help technicians identify and address issues in real-time.

Autonomous Fleet and Telematics Optimization:
AI agents monitor the movement and performance of vehicles, drones, and delivery units. Based on real-time conditions, routes are optimized to reduce delays and improve asset usage and efficiency.

Defense, Aerospace, and Emergency Response

In high-risk environments, decision-making depends on having the right information at the right moment. Identifying what matters most, when it matters most, is crucial — two capabilities make that possible:

Cognitive Load Reduction in High-Stakes Environments:
AI-led AR displays filter noise and present the most relevant inputs to the user. This further reduces the burden and helps teams make quick decisions.

High-Fidelity Synthetic Training:
Teams train using VR simulators that mimic real-world conditions, including weather changes, device issues, and structural risks.

What Does Integration and Convergence Actually Mean?

Physical AI and AI-led AR/VR only deliver value when they act as a system. That coordination happens through orchestration platforms like Tech Mahindra's Orion, Google's Gemini, Microsoft's Copilot, and other industry-led GenAI (LLMs).

They streamline the entire ecosystem. They collect sensor data from machines and robots, feed insights into AR/VR environments, and keep both layers aligned in real time.

From fault detection to workforce readiness, AI-driven alerts reach technicians as issues emerge, and digital twin insights carry directly into VR training scenarios.

Through GenAI, organizations move to an integrated loop of sense, decide, act, and share, the operating rhythm for the new era of modern operations.

The Multi-Tower Offering Model

An organization's operating model is structured across seven connected towers. Each area focuses on a specific function while sharing data, models, and governance infrastructure.

Coordination only works when it has a structure to run on. These towers are that structure, built around how physical AI actually gets deployed: from autonomous operations on the floor to the safety and governance layer that holds the whole system together.

Tower A:
Autonomous Operations and Robotics

Scope

Deploy intelligent automation across warehouses, factories, field operations, and logistics networks.

Core Capabilities

- AI-driven robotic arms pick, pack, and move goods on their own.
- **AMR:** movement of raw materials to finished goods, inventory
- monitoring, and maintenance of facilities infrastructure.
- **Cobots:** collaborative robots work in tandem with operators and technicians, adapt to their work style, and streamline process flow.
- Drones manage inspection, delivery, and monitoring in hard-to-reach or risky zones.

Benefits

- Lowers dependency on manual labor.
- Ability to sustain 24/7 operations without fatigue-related errors.
- Responds to changes and exceptions easily.
- Organizations can scale operations without increasing headcount.

Tower B:
Predictive Maintenance and Asset Intelligence

Scope

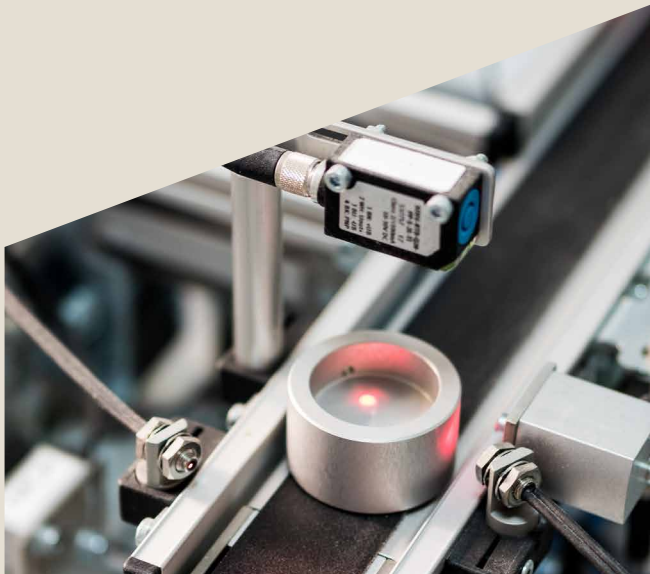
Maintenance is transforming from reactive fixes and rigid schedules. The focus now shifts to prescriptive approaches where issues are addressed before they disrupt operations.

Core Capabilities

- IoT sensors capture vibration, temperature, pressure, acoustic information, and so on from critical equipment.
- AI detects issues even before humans do.
- Digital twins create real-time replicas to simulate failures and fixes.
- AR tools support field technicians with step-by-step instructions, part identification, troubleshooting, and safety instructions.

Benefits

- Predictive maintenance is expected to grow at a CAGR of up to 18% through 2029, reflecting increasing enterprise investment.
- Reduces downtime as issues are identified and resolved proactively.
- Improves the lifespan of equipment through timely, targeted maintenance.
- Organizations can plan spare parts management with better demand predictions.



Tower C:
Immersive Training and Workforce Enablement

Scope

VR builds skills in controlled environments, and AR supports on-the-job performance.

Core Capabilities

- VR environments simulate high-risk scenarios in a controlled setting.
- AI adjusts the level of training modules, feedback, and learning paths based on trainee performance and requirements.
- AR provides on-the-job guidance, checklists, and expert assistance to field technicians.
- AR captures expert knowledge for reusable training content.

Benefits

- Time-to-productivity increases as new hires gain hands-on experience in simulated, realistic environments.
- Training costs are reduced by minimizing travel and equipment use.
- Repeated, risk-free practice enhances safety.
- Experts can support teams remotely.

Tower D:
Digital Twins and Simulation Platforms

Scope

Create virtual replicas of physical systems to plan, improve, and reduce risks.

Core Capabilities

- Digital twins can replicate entire plants, warehouses, or infrastructure networks, providing a real-time view of operations.
- Process simulation can be tested and evaluated before physical implementation.
- Scenario analysis explores "what-if" situations like demand surges, failures, and disruptions.
- AI suggests changes based on the feedback from digital twins.

Benefits

- The risk associated with design and operational decisions is reduced significantly.
- Reduces the time taken to set up new facilities or production lines.
- Continuous testing makes room for improvement without disrupting live operations.
- Operational technology (OT) and information technology (IT) teams work in a shared model.

Tower E:
Field Operations and Remote Collaboration

Scope

Improves execution consistency of distributed teams with real-time expertise and insights.

Core Capabilities

- AR guides technicians with real-time data on equipment during inspection and repairs.
- Remote experts and field workers can monitor faulty devices in real time, enabling guided troubleshooting.
- Drones or robots inspect and detect infrastructure issues.
- Dashboards show key data like IoT, weather, and operations for better decisions.

Benefits

- First-time resolution rate improves and minimizes truck rolls or repeat visits.
- Experts can support teams remotely.
- Safety improves as exposure to risks is reduced.
- Real-time visibility ensures faster responses.

Tower F:
Quality Assurance and Process Control

Scope

Embed AI into production and fulfillment workflows to ensure consistent quality.

Core Capabilities

- Detects defects, deviations, and errors instantly.
- AI-guided process adjustment recommends or automatically implements parameter changes to maintain quality targets.
- AR guides human inspectors through checklists and highlights areas that require attention.
- Root cause analysis to identify issues.

Benefits

- Reduces waste, rework, and returns.
- Reduces quality issues with early defect detection.
- Maintains quality records for regulatory compliance.
- Corrections happen in real time rather than at batch end.

Tower G:
Safety, Compliance, and Governance

Scope

Ensure physical AI and AR/VR systems operate within defined safety boundaries while meeting regulatory requirements.

Core Capabilities

- Safety-certified AI systems align with required safety standards (ISO 26262, IEC 61508) for critical use.
- Robots interact with each other in a controlled manner using sensors and emergency controls.
- Data protection frameworks address GDPR and other privacy regulations for AR/VR systems.
- Cybersecurity compliance helps protect hybrid infrastructures and applications (assets) from intrusion and supports responsible AI usage.
- Predictive analysis dashboards through AI decisions must be explainable through reasoning and auditable, ensuring decisions remain clear, traceable, and easy to review.

Benefits

- Builds trust with regulators, customers, and employees.
- Reduces exposure to legal and operational risk.
- Supports deployment in regulated industries such as healthcare, aviation, and energy.
- Ensures fair, transparent, and responsible use of AI.

The Backbone that Integrates Everything

To support dynamic real-world environments, backend towers and specialized support teams share five foundational layers, from a unified data platform to governance and security. This gives cross-functional teams the agility to resolve incidents, maintain security, and scale operations without duplicating infrastructure.

Unified Data Platform
Collates sensor streams, operational data, and AR/VR interaction logs into a common data lake

Digital Twin Engine
Simulation backbone for training, planning, and scenario analysis

Edge Compute Infrastructure
Low wait-time processing for real-time robotics and AR overlays

AI/ML Model Repository
Centralized repository for predictive maintenance, vision inspection, optimization, and NLP

Governance and Security Layer
Access control, compliance and auditability across deployment

Figure 2: Key Foundational Layers of Service Lines and Support Teams.

How to Drive Maximum Value?

With the foundation in place, the next question is how organizations turn it into ROI. Getting there takes four pillars that connect strategy to execution. Each pillar spans a different layer of the organization, from core architecture to commercial value realization, but only delivers ROI when tracked together.

Transformation Dimension	Core Focus Areas	Enterprise Business Impact
Technology and Core Architecture	▪ Multimodal foundation tuning ▪ Edge-cloud hybrid design ▪ Real-time data pipeline optimization	▪ Drastically reduces processing latency ▪ Keeps mission-critical operations functional offline ▪ Future-proofs spatial architectures
Operational and Process Design	▪ Restructuring tasks around hands-free data ▪ Automating manual inspection tasks ▪ Closed-loop robotic telemetryoptimization	▪ Lowers operational errors by 30–40% ▪ Speeds up mean-time-to-repair (MTTR) ▪ Maximizes equipment utilization
Human Augmentation and Safety	▪ Reducing cognitive load via predictive UI ▪ Biometric and environmental hazard alerts ▪ Simulated hazardous environment practice	▪ Drops workplace safety incidents significantly ▪ Accelerates expert skill acquisition ▪ Enhances frontline worker retention
Commercial and Value Realization	▪ Shifting from CAPEX to outcome-based OPEX ▪ Granular tracking of asset downtime reduction ▪ Scale-ready cost structures	▪ Provides measurable, rapid ROI ▪ Lowers initial infrastructure investment barriers ▪ Ties IT spending directly to business outcomes

Implementation Roadmap

Transformation rarely succeeds as one large leap. Progress typically comes in stages, starting with clear objectives and governance groundwork, then pilot projects that prove value before scaling. Many programs stall when organizations try to scale before that foundation is ready, which is why sequencing matters as much as the technology itself.
Tech Mahindra recommends the following phases:

Phase 1
Months 1–4

Assess

- Identify current operational pain points and automation maturity
- Deploy pilot projects in 1–2 towers with highest ROI potential (often predictive maintenance and AR-assisted field services)
- Establish data integration and governance baselines

Phase 2
Months 5–15

Scale

- Expand successful pilots to additional sites and use cases
- Introduce digital twin capabilities to support planning, execution and simulation
- Deploy autonomous operations in controlled environments
- Visualize geospatial digital elevation models (captured via LiDAR and RADAR) in VR

Phase 3
Months 16–26

Optimize

- Connect towers into integrated workflows (e.g., digital twin feeding training scenarios, predictive maintenance triggering AR work orders)
- Implement AI-driven continuous improvement loops with dashboard reporting
- Extend to mission-critical and regulated applications with full safety certification

Figure 3: Three-Phase Implementation Roadmap

What Enterprises Gain?

Individual towers already deliver value. Combined, they compound it. A predictive maintenance alert can update a training scenario. A digital twin can flag a safety risk before a routine inspection catches it. A field sensor reading can adjust a fleet route as conditions change. This is the return the multi-tower model is designed to capture.

Operational Efficiency

- 25-40% reduction in Ops downtime
- Faster cycle times through automation
- Break-fixes for critical assets at first attempt by pairing of real-time AR assist

Workforce Productivity

- Accelerated & Interactive trainings
- Improved first-time fix rates
- Experts leveraged across geographies

Quality and Consistency

- Fewer defects
- Minimal rework
- Auditable compliance records

Safety

- Active spatial visualizations
- Reduced human exposure to hazards
- Zero-incident track records achieved via robotic deployments

Agility

- Ability to simulate, validate changes before physical implementation
- Expedited services & stable operations
- Faster response to market shifts

Capital Efficiency

- De-risked investments through digital twin validation
- Extended asset lifecycles
- Productivity improvements & High ROI

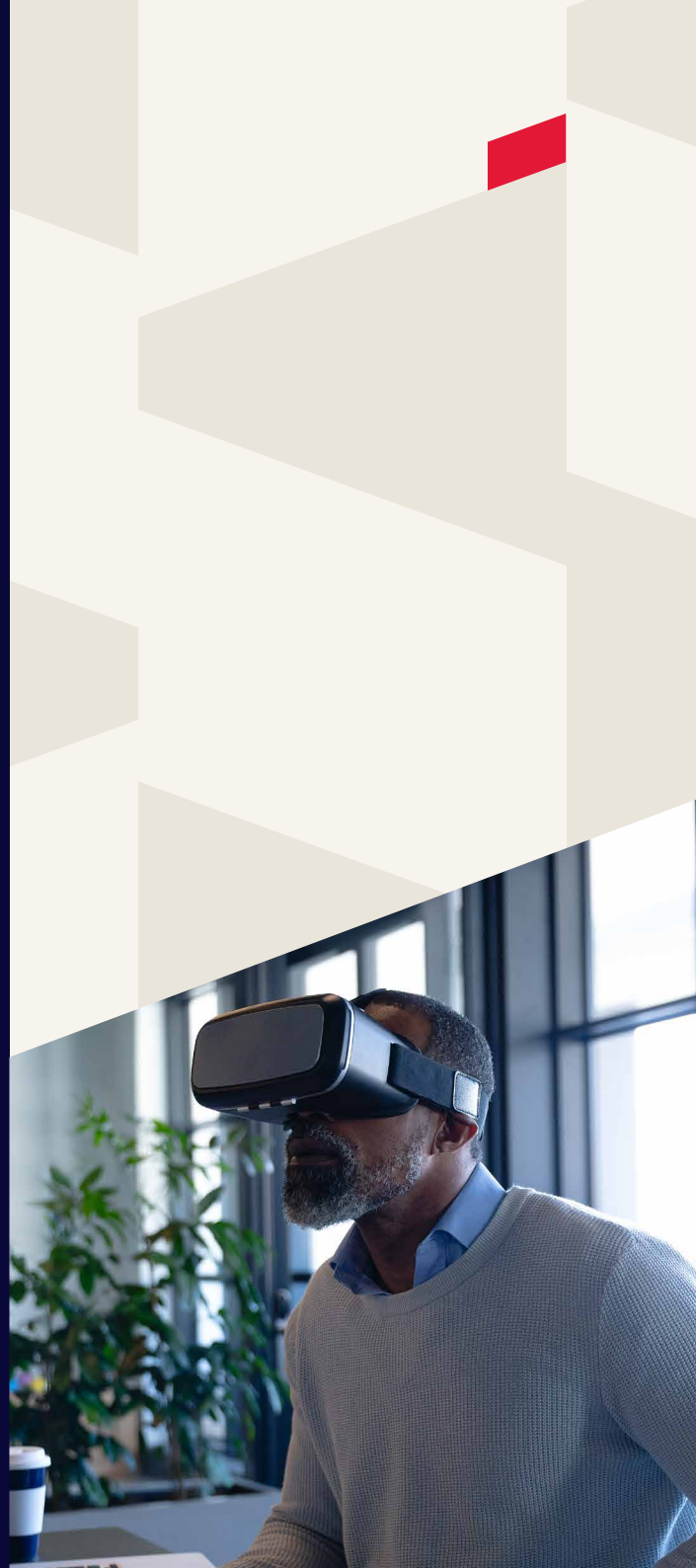
Conclusion

Physical AI and AI-led AR/VR deliver the most value as one connected system. The organizations furthest along this path started with clear governance and data foundations, then scaled tower by tower.

For operations leaders, the starting point is an honest assessment of which one or two towers offer the fastest path to ROI. For CIOs and IT leaders, it is the data and governance foundation that lets those towers scale. For safety and compliance teams, early involvement builds governance into deployment from the start.

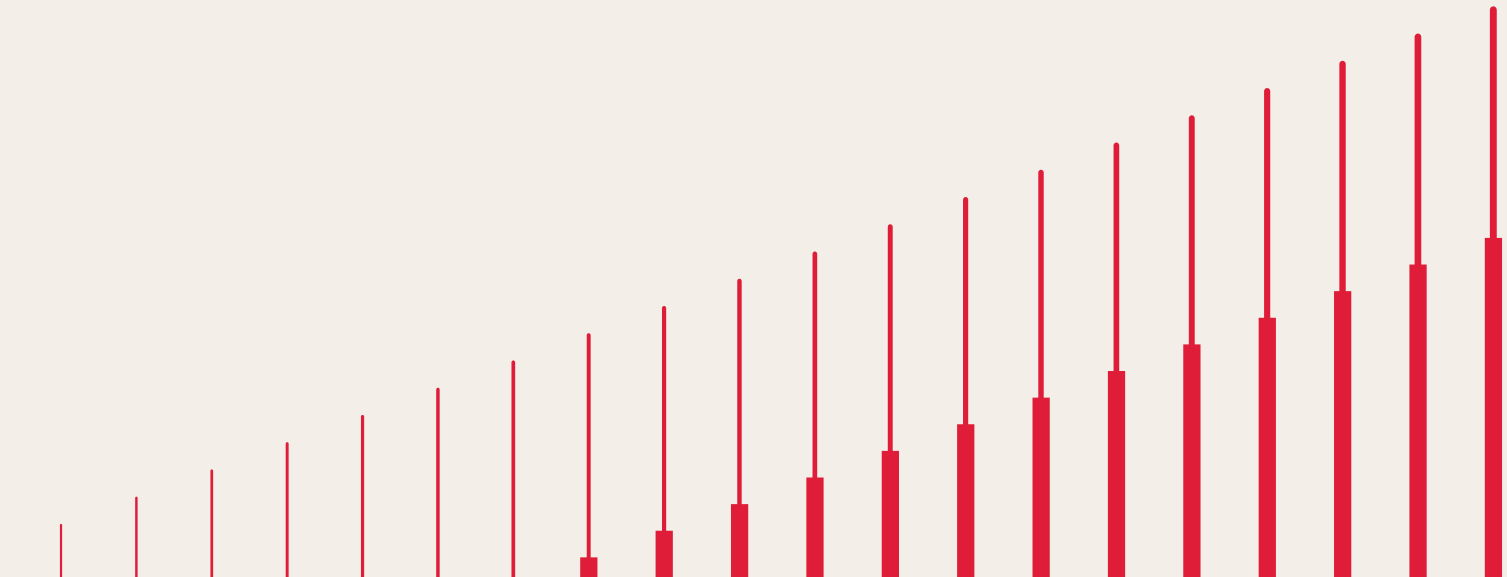
This sequencing matters more than the technology choice itself. A digital twin or an AR headset delivers limited value on its own; the return comes from how towers connect and share data across the operation. Tech Mahindra's multi-tower model gives organizations that structure from the outset, before separate pilots harden into disconnected systems.

As spatial computing and generative AI mature, the operating model will keep evolving. A flexible, governed foundation now prepares organizations to adopt what comes next.



About the Author

Ganesh P is a passionate, technology-savvy professional and contributor with 30 years of comprehensive experience, serving global enterprise clients across all major geographies and playing various roles across multiple businesses, industry verticals, and technology domains, with strong presales and consulting expertise. He led practice delivery and drove e2e business/technology transformations by building, delivering value, and creating positive business impacts for global enterprises.



Ganesh P
Enterprise Architect - Large Deals, Strategic Solutions & Transformation, Tech Mahindra

About **Tech Mahindra**

Tech Mahindra (NSE: TECHM, BSE: 532755) offers technology consulting and digital solutions to global enterprises across industries, enabling transformative scale at unparalleled speed. With 146,000+ professionals across 90 countries, Tech Mahindra provides a full spectrum of services including consulting, information technology, enterprise applications, business process services, engineering services, network services, customer experience & design, AI & analytics, and cloud & infrastructure services. It is the first Indian company in the world to have been awarded the Sustainable Markets Initiative's Terra Carta Seal, which recognizes global companies that are actively leading the charge to create a climate and nature-positive future. Tech Mahindra is part of the Mahindra Group, founded in 1945, one of the largest and most admired multinational federation of companies.

www.techmahindra.com
www.twitter.com/tech_mahindra
www.linkedin.com/company/tech-mahindra