

IOT futuristic integration with ERP systems: A review

Arjun Reddy Kunduru

Independent Researcher, Orlando, FL, USA

Abstract: The Internet of Things (IoT) and Enterprise Resource Planning (ERP) are two of the most disruptive information technologies, changing how modern enterprises operate. IoT enables connecting physical objects like machines, assets, and goods embedded with sensors, software, and connectivity to collect and exchange data over the internet. ERP software integrates business processes across departments into unified systems for insight and automation. Integrating IoT with ERP is an enormous opportunity for digital transformation across functions like manufacturing, logistics, and asset management. This research article provides a comprehensive analysis of the current status, key drivers, future potential, challenges, emerging approaches, and best practices related to IoT-ERP integration. While early use cases involve the basic connectivity of IoT with ERP for real-time visibility and reporting, huge potential exists for transformative changes through tighter convergence, like autonomous operations, intelligent workflows, new business models, etc. However, organizations face significant technology and business challenges around connectivity, data, security, integration complexity, skill shortages, and change management. The article discusses strategies to overcome these multifaceted challenges.

Various integration approaches are emerging, leveraging specialized middleware, ERP vendor IoT platforms, partner ecosystems, integration platforms as a service, APIs, and microservices. Enterprises need to assess their landscape and priorities to pick optimal techniques. Adopting best practices around case-driven pilots, flexible integration architecture, cross-functional teams, and industry benchmarks can maximize benefits while minimizing risks. With aging legacy ERP and exponential IoT growth, integrating the two technologies is urgent for future success. When systematically implemented, integrated IoT and ERP will form the core digital platforms, enabling smarter, more efficient, and more innovative future enterprises.

Keywords: IoT, ERP, Integrations, Data Analytics

Introduction

The Internet of Things (IoT) is rapidly evolving to become an integral part of future enterprise information systems. IoT refers to the network of physical objects embedded with sensors, software, electronics, and connectivity that allows them to connect, interact, and exchange data over the internet. This enables objects to be monitored, controlled, and automated remotely. According to Gartner, there will be over 25 billion IoT devices deployed by 2021. On the other hand, Enterprise Resource Planning (ERP) software enables organizations to use integrated applications to manage business functions such as supply chain, accounting, project management, compliance, and other critical processes. ERP systems have been the backbone of enterprise operations for decades. Integrating IoT with ERP systems is the next significant opportunity for

digital transformation across industries. Combining real-time data from connected things with the orchestration capabilities of ERP can transform business processes to be intelligent, proactive, and autonomous. This research article provides a comprehensive analysis of IoT-ERP integration, including current status, key drivers, future potential, challenges, emerging approaches, and recommendations.

Current Status of IoT-ERP Integration:

IoT and ERP systems have co-existed in isolation for many years within enterprises. IoT includes sensors, wearables, connected equipment, and other endpoints that collect and transmit data over wired and wireless networks. ERP software consolidates transactional data across business processes into integrated databases for reporting, analytics, and process automation. According to IDC, less than 30% of IT decision-makers have currently integrated IoT with their ERP systems. However, there is significant interest across industries to leverage IoT data for enriching ERP, especially in asset-intensive domains such as manufacturing, logistics, oil, and gas.

The most common use cases today involve the basic integration of ERP software with IoT devices for benefits such as asset tracking, workflow automation, enhanced reporting, and overall equipment effectiveness. For example, sensors installed on warehouse conveyors can track the movement of material and trigger automated alerts in the ERP when inventory falls below certain thresholds. Airlines integrate RFID bag tags with an ERP luggage tracking system to monitor status and location in real-time. Telematics data from fleet trucks integrated with ERP provides real-time visibility for logistics providers. Manufacturers attach sensors to detect vibrations, temperature, etc. for predictive maintenance of equipment integrated with maintenance modules of ERP. However, in most of these use cases, IoT largely provides data to enhance certain ERP functions, but the integrations are limited in scope. The convergence is still maturing, and substantial efforts are required to develop skills, technology capabilities, and new operating models to realize its full potential.

Key Drivers for Integrating IoT and ERP Systems:

While early implementations have been exploratory in nature, several important factors are driving enterprises across industries to undertake more strategic and transformational integration of IoT and ERP:

1. **Improved Data Analytics:** IoT generates massive amounts of real-time contextual data from connected sensors, devices, and assets across locations. Combining this data with structured ERP records in an integrated data platform provides unmatched volume, variety, and granularity of information. Applying analytical and AI techniques to this aggregated data offers new metrics, insights, and intelligence for enhanced decision-making.

2. **Process Optimization:** Data from IoT enables precise tracking, monitoring, and visibility of workflows, inventory, assets, shipments, equipment, etc. Combining this level of real-time visibility with ERP orchestration capabilities allows processes like production, maintenance, logistics, and field service to be dynamically optimized for efficiency gains.

3. Richer Reporting: IoT expands the amount of available operational data severalfold when integrated with ERP systems. This powers the move from static, periodic reports to dynamic reporting with much higher granularity in areas like overall equipment effectiveness (OEE), asset lifecycle costs, field service response times, etc.

4. Digital Twin Modeling: IoT data combined with design, engineering, and operational data from ERP systems enables creating dynamically updating digital twins of assets, equipment, and workflows. This allows companies to simulate scenarios and optimize operations.

5. New Risk Insights: Behavioral anomalies and patterns detected from IoT data integrated with ERP can provide proactive risk insights and predictive analytics for issues like equipment failures, delayed shipments, fraudulent transactions, etc.

6. Digital Business Models: IoT allows products to be transformed into intelligent, connected services by collecting usage or outcome data. Combined with ERP, this unlocks the ability to offer innovative service-based business models like equipment-as-a-service.

As these drivers illustrate, integrated IoT-ERP systems form the digital core of future smart enterprises. Leading organizations are thus exploring more disruptive use cases spanning autonomous operations, intelligent processes, and data monetization.

Futuristic Transformative Potential of Integrated IoT-ERP:

While current implementations involve tactical point-use cases, there is significant long-term potential to apply IoT-ERP convergence for next-generation transformation.

1. Autonomous Operations: IoT data combined with ERP allows processes to be automated based on real-time triggers and algorithms. This enables 'lights-out' operations requiring minimal human intervention across functions like predictive maintenance, inventory replenishment, quality testing.

2. Intelligent Processes: Combining IoT data with the ML/AI capabilities of ERP systems provides enterprise-wide visibility to optimize, guide, and enhance end-to-end business processes intelligently. Humans can focus on higher judgment while IoT+ERP makes routine decisions.

3. Smart Factories: In manufacturing, IoT data from connected equipment integrated with ERP systems can orchestrate smart factories where machines and workflows are flexible, intelligent, and autonomous. This unlocks model-based manufacturing.

4. Digital Products: With IoT, traditional products can transform into intelligent, connected products by embedding sensors and connectivity. Combined with ERP, this allows innovative digital business models based on continual product monitoring and usage-based pricing.

5. Predictive Maintenance: Granular equipment monitoring with sensors enables analyzing signal data to accurately predict maintenance needs even before failure. Combined with ERP maintenance modules, this enables lower downtime through predictive maintenance capabilities.

6. Cognitive Supply Chains: Real-time data on inventory, shipments and assets enables dynamic optimization of supply chains using simulations and algorithms. Integrated with ERP, this allows 'sense and respond' cognitive supply chains of the future.

7. Hybrid Service Models: IoT usage data combined with ERP allows traditional product sales to be augmented with value-added services and outcomes. This enables hybrid product-service business models with recurring revenues.

The futuristic scenarios powered by IoT-ERP integration illustrate that it is a vital component of enterprise digital transformation. However, there are significant challenges involved in integrating these complex systems that need a strategic approach.

Challenges and Risks of Integrating IoT and ERP:

While the potential benefits are compelling, integrating IoT with ERP poses multifaceted technical and business challenges.

1. Connectivity Protocols: There are no common standards yet for IoT connectivity. Supporting diverse protocols like WiFi, Bluetooth, and LPWAN across a heterogeneous device landscape makes integration tricky.

2. Data Management: The volume, velocity, variety, and veracity of IoT data require advanced techniques to filter, process, store, and structure data before integrating with ERP.

3. Legacy ERP systems: monolithic architectures and outdated legacy ERP systems designed before IoT lack flexibility and openness for easy integration with modern distributed IoT architectures.

4. Cybersecurity: Connecting ERP systems with external IoT endpoints exponentially expands potential attack surfaces and risks of cyber threats, which could cripple operations. Holistic security strategies are essential.

5. Talent Shortage: Most organizations lack integrated skillsets spanning both IoT and ERP domains, which are essential to designing and implementing such converged architectures. Re-skilling or hiring cross-functional talent is vital.

6. Change Resistance: Integrating emerging technologies like IoT with legacy ERP requires changing entrenched operating models. This faces cultural resistance issues that must be addressed through leadership, communication, and training.

7. Uncertain ROI: Comprehensive cost-benefit justification of large-scale IoT-ERP integration is difficult due to intangible benefits and a lack of precedents. Securing stakeholder buy-in for investments poses hurdles.

8. Vendor Silos: Historically, there has been minimal collaboration among major IoT and ERP vendors. This causes integration challenges as products have been designed in silos. Vendor ecosystems need to align and co-innovate for convergence.

These challenges across people, processes, technology, and governance make IoT-ERP integration complex. But taking an evolutionary approach focused on specific use cases can help validate value and scale organically.

Emerging Approaches for Integrating IoT and ERP Systems:

As next-generation use cases gain traction, enterprises are exploring innovative technology approaches to integrate IoT and ERP.

1. Specialized Integration Middleware: These are tools like Dell Boomi and Oracle Integration Cloud that provide connectors, messaging queues, and data models for easy integration of diverse systems like IoT and ERP.

2. IoT Capabilities in ERP: Modern ERP platforms like SAP Leonardo and Oracle ERP Cloud have built-in IoT capabilities for cloud integration, digital twins, etc. that simplify convergence.

3. Partner Ecosystems: ERP vendors are encouraging their strategic IoT partners to develop solution accelerators to ease integration. Joint solutions like Azure IoT and SAP ERP accelerate outcomes.

4. Integration Platform as a Service: Leveraging cloud-based iPaaS like MuleSoft, SnapLogic provides agile integration of IoT with ERP through drag-and-drop flows, pre-built connectors, etc.

5. Lightweight APIs and Microservices: Adopting API-based integration fabric and microservices architecture for extensions enables loose coupling between IoT and ERP in a scalable manner.

6. Immersive Technologies: The use of augmented reality with IoT data visualization integrated with ERP modules provides immersive capabilities for notifications, alerts, and decision support.

7. Hybrid Integration: Blending aspects of the above approaches, like iPaaS for cloud integration and APIs for edge integration, provides flexibility and balances tradeoffs.

Each of these emerging approaches has its own strengths and limitations. Enterprises need to assess their legacy landscape, use case priorities, IT roadmap, skill availability, and other factors to pick optimal integration strategies that can evolve over time as technology and business needs advance.

Best Practices for IoT-ERP Integration:

Based on pioneering implementations, the following best practices have emerged for maximizing benefits:

- Start with a pilot project with clear business goals to validate ROI before large-scale integration.
- Assess the gaps between IoT and ERP data models and processes that need to be bridged.

- Leverage vendor solution accelerators and system integrators to jumpstart integration.
- Adopt flexible integration approaches using the cloud, APIs, and microservices for agile changes.
- Analyze integration needs at the edge between IoT and core ERP to optimize data flows.
- Focus on master data management and data security across the integrated IoT-ERP landscape.
- Develop reusable technology components like APIs and algorithms for accelerated future rollouts.

By strategically following these recommendations, the risks and challenges can be mitigated for the successful implementation of IoT-ERP integration projects in line with business priorities.

Conclusion:

In conclusion, integrating IoT and ERP systems is poised to be the next frontier of digital transformation for future-ready enterprises across industries. While current integrations are limited to basic use cases, huge potential exists to use IoT-ERP convergence for disruptive transformation spanning autonomous operations, intelligent processes, predictive analytics, and new business models. However, to fully harness this potential, the multifaceted integration challenges require a strategic approach focused on specific high-value use cases, adopting flexible integration architectures, re-skilling talent, and following industry best practices. With aging legacy ERP systems and exponential growth in IoT, there is an urgent need for forward-looking businesses to formulate IoT-ERP integration roadmaps aligned to their digital transformation strategy. When systematically implemented, integrated IoT and ERP will form the digital core, enabling enterprises to become smarter, more efficient, and more innovative in the hyperconnected world of the future.

References:

1. Pan, M., Sikorski, J., Kastner, C. A., Akroyd, J., Mosbach, S., Lau, R., & Kraft, M. (2020). Digital Twin for Industry 4.0: The Self-Organizing Map Approach. *IEEE Transactions on Industrial Informatics*, 16(6), 4119-4128.
2. O'Donovan, P., Leahy, K., Bruton, K., & O'Sullivan, D. T. (2015). An industrial big data pipeline for data-driven analytics maintenance applications in large-scale smart manufacturing facilities. *Journal of Big Data*, 2(1), 25.
3. Zhou, K., Taigang, L., & Lifeng, Z. (2015). Industry 4.0: Towards future industrial opportunities and challenges. 2015 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD). doi:10.1109/fskd.2015.7382284
4. Shrouf, F., Ordieres, J., & Miragliotta, G. (2014). Smart factories in Industry 4.0: A review of the concept and of energy management approached in production based on the Internet of Things paradigm. 2014 IEEE International Conference on Industrial Engineering and Engineering Management. doi:10.1109/ieem.2014.7058728
5. Skola, I., & Liepins, E. (2018). Integration of Internet of Things in Enterprise Information Systems for Real-Time Data Collection and Enhanced Situation Awareness. *Procedia Computer Science*, 104, 157–164. doi: 10.1016/j.procs.2017.11.054
6. Vermesan, O., & Friess, P. (Eds.). (2014). *Internet of things-from research and innovation to market deployment* (Vol. 29). River publishers.

7. Bottani, E. (2019). Digital supply chain transformation toward supply chain 4.0: a literature review. Logistics. doi: 10.3390/logistics3010009
8. Reaidy, P. J., Gunasekaran, A., & Spalanzani, A. (2015). Bottom-up approach based on Internet of Things for order fulfillment in a collaborative warehousing environment. International Journal of Production Economics, 159, 29-40.

