

Perspective



Real time information for the pervasive enterprise

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Abstract

Enterprises need real time visibility into operations to be responsive to market dynamics and competition. Pervasive technologies hold the promise of providing companies real time visibility, transforming the way they make decisions. This Infosys paper provides pointers to the right architecture to help leverage these technologies and transform an organization into a pervasive enterprise.

Real time visibility in a dynamic world

In a world of integrated supply chains and outsourced business processes, companies need information real time. Business needs e.g., new promotions and product launches, demand rapid responses and accurate decision-making. However, this may not be possible with the traditional post analysis, planning and implementation.

The lack of real time visibility into operations leads to insufficient coordination between the physical flow of materials and the associated flow of digital information. This can skew demand variability at each level in the supply chain - a phenomenon popularly known as the 'bullwhip effect'.

For accurate and timely decision making, visibility into the supply chain, products and assets is critical. For instance, during promotions, real time information visibility can help track pre-launch metrics, ensure compliance and provide audit trails for better execution. In the case of product recalls, better visibility can ensure compliance to regulations and help reduce legal liability. (For more information on the advantages of real time visibility across the supply chain, please see Appendix I).

Technologies like Radio Frequency Identification (RFID) or smart-tags have the potential to transform companies into pervasive enterprises. These technologies create human-independent systems to detect, interpret and react to business events in real time. Here is how two smart companies successfully leverage pervasive technologies:

Medical device manufacturer monitors inventory real time	Retailer uses real time monitoring to enhance shopping experience
<p>A manufacturer of high value medical devices relies on smart storage systems for real-time item-level inventory visibility. The consumption of its products is geographically widespread with limited or no IT support. The storage system, however, is smart enough to sense the RFID-tagged products and register the events that occur. It then communicates these developments to an enterprise system in a timely manner over a wireless network.</p> <p>The enterprise system based on pre-defined business rules makes an autonomous decision. This is communicated to field sales representatives through personal digital assistants (PDAs), which instruct representatives on actions to be taken.</p> <p>The system enables savings potential year-on-year by reducing out-of-stocks, product expirations and the cash flow cycles.</p>	<p>A large format retailer has deployed electronic smart shopping assistants (SSA) for an interactive customer experience. The SSA has an intuitive interface that allows customers to access shopping lists and locate products in store. It provides pricing and other merchandise information, and also enables self-check out of items. The device enables meaningful interaction in the form of information, offers and product promotions based on the customer's location in the store. The SSA also communicates the transaction context for offline analysis and insights to headquarters.</p> <p>Leveraging the system, the retailer has combined the economies of scale of a large format with the agility and high-touch of a mom-and-pop set-up.</p>

Pervasive technologies for better visibility

Recent technological advances enable businesses to detect, interpret and react to events as they occur through enhanced visibility and decision-support tools. Technology is creating an environment where:

- Access is becoming ubiquitous through multiple interoperable access technologies - Wi-Fi, Bluetooth, GSM/GPRS/CDMA, etc.
- Computing is becoming pervasive with the availability of low cost, low horsepower capabilities like motes, ARM processors, PDAs and mobile software platforms

These advances are paving the way for smarter sensors to be embedded into products. This technology convergence means enterprises can now leverage:

- Embedded sensors and computing power on 'smart objects' to detect key events, collect data and execute decisions
- Wireless communication interfaces to communicate with enterprise systems about business events and enable decision making
- Real time enterprise information architecture to analyze the impact and make autonomous decisions on responses

A strategic approach to building a pervasive enterprise

Enterprises that aim to leverage real time information visibility from pervasive technologies must gear up to deal with the resulting multi-dimensional impact. From creating and managing new innovative applications, the change management process will extend to dealing with trading partners through complex business models.

To enable a smooth transition to real time decision making, it is essential to establish a common understanding across the organization. This includes understanding what the paradigm shift means and how best to leverage existing technology investments.

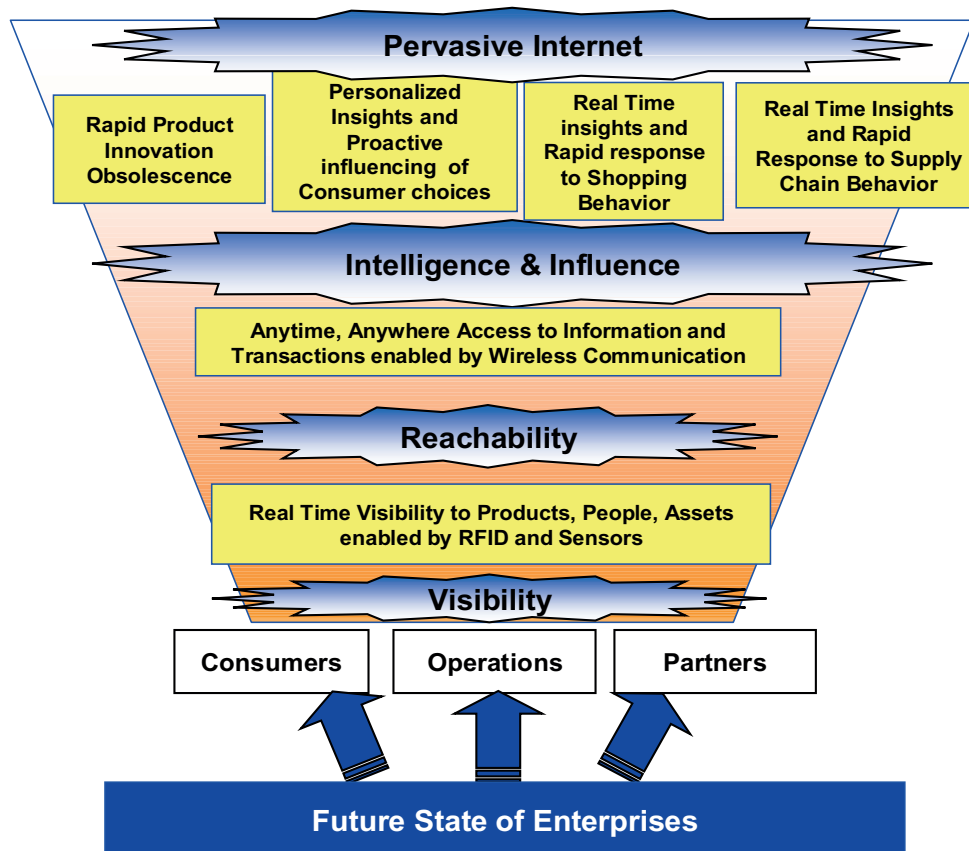
A robust information architecture strategy can enable common understanding across the organization. It will also provide a framework to implement the required technology architecture capabilities.

Architecture for the pervasive enterprise

Most existing enterprise applications are not geared for real-time interactivity with the physical world. Moreover, current EAI solutions do not comprehensively address the impact. It is not advisable to reengineer applications as point solution extensions. These would be neither scalable, nor effective from a total cost of ownership standpoint.

Enterprises must lay an architectural foundation to enable real time sense and business intelligence powered response. The architecture must include:

- Real time asynchronous event handling involving multiple devices and software systems via multiple communication channels
- Decision making in real-time, in low horsepower computing environments
- Platform agnostic real time availability of enterprise systems to pervasive consumers (devices, systems, et al)
- Ability to leverage insights from off-line analysis for real-time decision making
- Ability to learn from real world events and respond in real time



The 7-layer reference model for success in transformation

Infosys' 7 layer reference model for an RFID-enabled enterprise (Figure 1) shows how organizations can leverage real time information visibility from pervasive technologies:

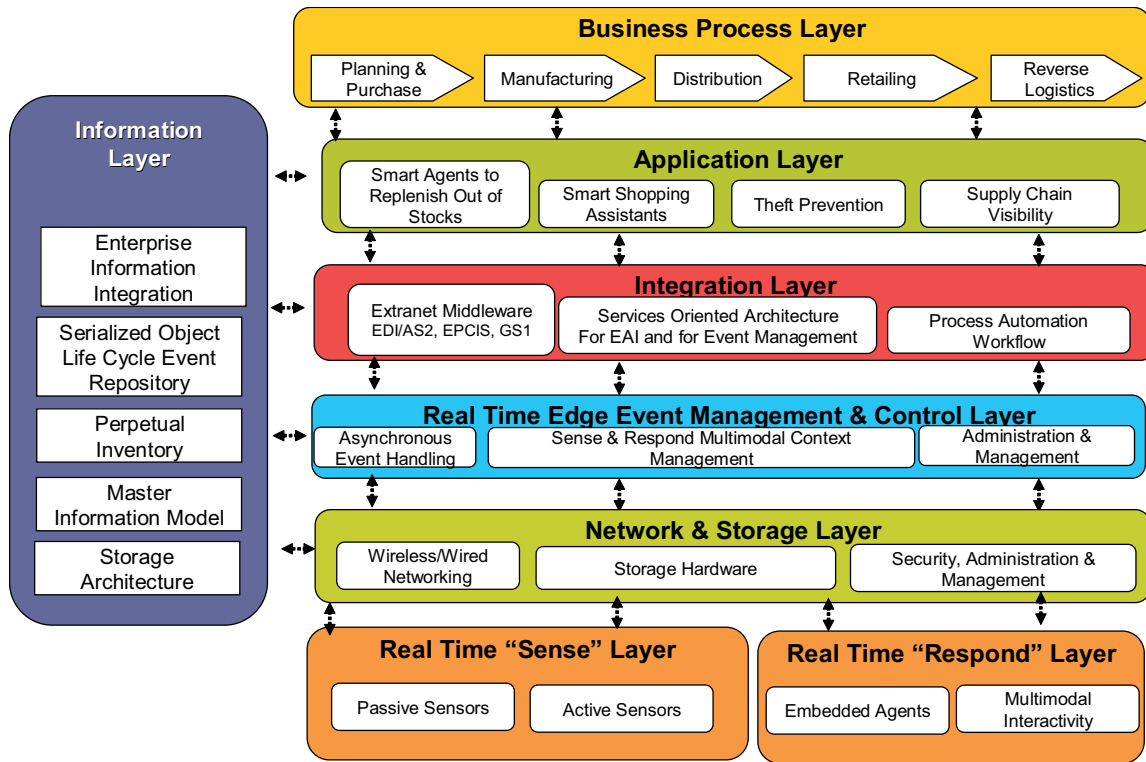


Figure 1: Infosys' 7 layer reference model for an RFID-enabled enterprise

The **Real Time Sense Layer** comprises hardware for detecting or sensing physical events of business significance. It includes RFID tags (chip and antenna), the label for RFID tags, RFID printer, RFID reader and the RFID reader antenna as well as other sensors (temperature, pressure, motion detection, etc.).

The **Real Time Respond Layer** consists of mobile computing devices that can provide multi-modal interactivity (audio, visual) and run embedded agent software. It is involved in interpreting and responding to physical events.

The **Network & Storage Layer** is where RFID data is stored at the edge and centrally within the enterprise. It includes various network types that enable extranet-based access to data for trading partners. These networks can include 802.11b-based wireless networks, Ethernet-based and serial networks, network security, administration and management, and a wide area network.

The **Real Time Edge Event Management and Control Layer** provides RFID middleware capabilities as well as the ability to control and communicate with other devices.

The **Enterprise Integration Layer** has three key components: The first comprises of an extranet middleware including the electronic data interface (EDI) communications system, the global data pools, and EPC Information Services. The second is a services oriented architecture for enterprise application integration (EAI) and enterprise event management. The last component consists of the business process automation and workflow engines.

The **Information Layer** includes the following:

- Master information model and repository – a central reference for all global identifiers (GTIN), global location number (GLN), etc.
- Perpetual inventory repository – a central and edge-based repository with location inventory visibility
- Object life cycle event repository – a central and edge-based data warehouse of life cycle events associated with an RFID tagged object

- Enterprise information integration engine – a central and edge-based engine to correlate life cycle events with other business events within the enterprise. This engine also executes rules in response to triggers like events or alerts to various business decision making systems.

The **Application Layer** consists of existing business applications and a breed of new applications based on the agent paradigm to enable real time autonomous decision making within the enterprise.

The **Business Process Layer** includes all the business processes in the organization that leverage RFID data to automate operations or for real time decision making.

Conclusion

With visibility enhanced by pervasive and ubiquitous wireless technologies, Infosys foresees the evolution of a 'Pervasive Internet of Things'. This will enable enterprises to gain insights and influence consumer behavior through real time intelligence, and innovate faster to become more competitive.

About the Authors

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Appendix I: What you need to see – and what’s blocking your view

The chart below provides insights on challenges to and benefits from improved visibility in various areas of operation:

Area	Information Visibility Desired	Benefits	Challenges
Promotions	<ul style="list-style-type: none"> • Location of displays • Location of inventory • End-cap activity 	<ul style="list-style-type: none"> • Track pre-launch metrics • Ensure compliance • Audit trails to improve execution 	<ul style="list-style-type: none"> • Item-level visibility • Diversity of locations • Identifying significant shelf activity • Sharing relevant information securely
New Product Introduction	<ul style="list-style-type: none"> • Location of inventory • Monitoring Shelf activity 	<ul style="list-style-type: none"> • Contractual compliance • Leading indicators on product off-take 	<ul style="list-style-type: none"> • Item-level visibility • Identifying storage locations across the supply chain • Identifying significant shelf activity • Sharing relevant information securely
Plan-o-gram Compliance	<ul style="list-style-type: none"> • Location visibility to displayed products • Shelf activity monitoring 	<ul style="list-style-type: none"> • Ensure consistent consumer experience 	<ul style="list-style-type: none"> • Visibility to displayed products • Multiple display formats • Identifying significant shelf activity • Sharing relevant information securely
Replenishments	<ul style="list-style-type: none"> • Inventory visibility across supply chain 	<ul style="list-style-type: none"> • Reduce stock-outs • Improve sales 	<ul style="list-style-type: none"> • Detecting out of stock (OOS) situations real time • Identifying thresholds to respond • Sharing relevant information securely
Markdowns	<ul style="list-style-type: none"> • Inventory ageing across supply chain 	<ul style="list-style-type: none"> • Leading indicators on product off-take • Reduce or eliminate markdowns • Employ real-time markdown strategies 	<ul style="list-style-type: none"> • Detecting inventory ageing situations in real-time • Identifying thresholds to respond • Being able to mark down selectively, based on shopping behavior of consumers • Sharing relevant information securely
Product Recalls	<ul style="list-style-type: none"> • Location visibility to recalled products 	<ul style="list-style-type: none"> • Compliance to regulations • Reduce legal liability 	<ul style="list-style-type: none"> • Ensuring Item level visibility to recalled product • Identifying storage locations in a standard and consistent manner across the supply chain

Area	Information Visibility Desired	Benefits	Challenges
Product Expirations	<ul style="list-style-type: none"> • Inventory ageing across supply chain • Location visibility to expiring products 	<ul style="list-style-type: none"> • Reducing lost sales • Reducing shrink 	<ul style="list-style-type: none"> • Item-level visibility to expiring products • Detecting expiry situations in real-time • Identifying thresholds to respond • Identifying storage locations in a standard and consistent manner across the supply chain
Cold Chain Management	<ul style="list-style-type: none"> • Temperature threshold events through the life cycle 	<ul style="list-style-type: none"> • Regulatory compliance • Quality compliance • Reducing shrink and lost sales • Ensuring customer satisfaction 	<ul style="list-style-type: none"> • Item-level visibility to monitored products • Visibility to life cycle events of significance • Detecting temperature exposure situations in real time • Identifying thresholds to respond
Regulatory Compliance – FDA, Pedigree	<ul style="list-style-type: none"> • Secure, authenticated track & trace audit trails through the life cycle 	<ul style="list-style-type: none"> • Regulatory compliance • Reduce legal liability 	<ul style="list-style-type: none"> • Ensuring item-level visibility to monitored products • Ensuring visibility to life cycle events of significance through secure and authenticated means
Loss Prevention	<ul style="list-style-type: none"> • Track & Trace audit trails 	<ul style="list-style-type: none"> • Reducing shrink and lost sales 	<ul style="list-style-type: none"> • Ensuring item-level visibility to monitored products • Ensuring visibility to life cycle events of significance
Perpetual Inventory	<ul style="list-style-type: none"> • Inventory accuracy across the supply chain 	<ul style="list-style-type: none"> • Visibility at the corporate level to assist in financial and other related planning functions • Compliance to regulations 	<ul style="list-style-type: none"> • Identifying life cycle events of significance • Ensuring item-level visibility to monitored products • Ensuring visibility to life cycle events of significance
In-Store Consumer Behavior	<ul style="list-style-type: none"> • Visibility to consumer movement • Visibility to consumer cart or basket of activity 	<ul style="list-style-type: none"> • Better real estate management • Improved consumer experience • Leading indicators on consumer response 	<ul style="list-style-type: none"> • Ensuring item-level visibility to monitored products and assets • Identifying events of significance • Identifying storage locations in a standard and consistent manner across the supply chain

Area	Information Visibility Desired	Benefits	Challenges
After sales	<ul style="list-style-type: none"> • Visibility to purchased goods • Visibility to consumption and usage 	<ul style="list-style-type: none"> • Better recalls • Tracking returns, repairs and warranties Improved customer satisfaction and brand loyalty • Proactively influence consumer behavior 	<ul style="list-style-type: none"> • Ensuring visibility to products at points of consumption or usage • Identifying events of significance • Identifying thresholds to proactively respond • Ensuring secure and private access to information
Reusable Assets	<ul style="list-style-type: none"> • Visibility to asset location • Visibility to lifecycle events 	<ul style="list-style-type: none"> • Reduce shrink and losses • Leading indicators on utilization 	<ul style="list-style-type: none"> • Ensuring asset-level visibility • Identifying storage locations in a standard and consistent manner across the supply chain • Identifying lifecycle events of significance • Sharing relevant information securely
People Tracking	<ul style="list-style-type: none"> • Visibility to people, location and movement 	<ul style="list-style-type: none"> • Increased security and reduced risks 	<ul style="list-style-type: none"> • Ensuring people visibility • Identifying storage locations in a standard and consistent manner across the supply chain • Sharing relevant information securely



About Infosys

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