

View Point



Pervasive Computing

Introduction

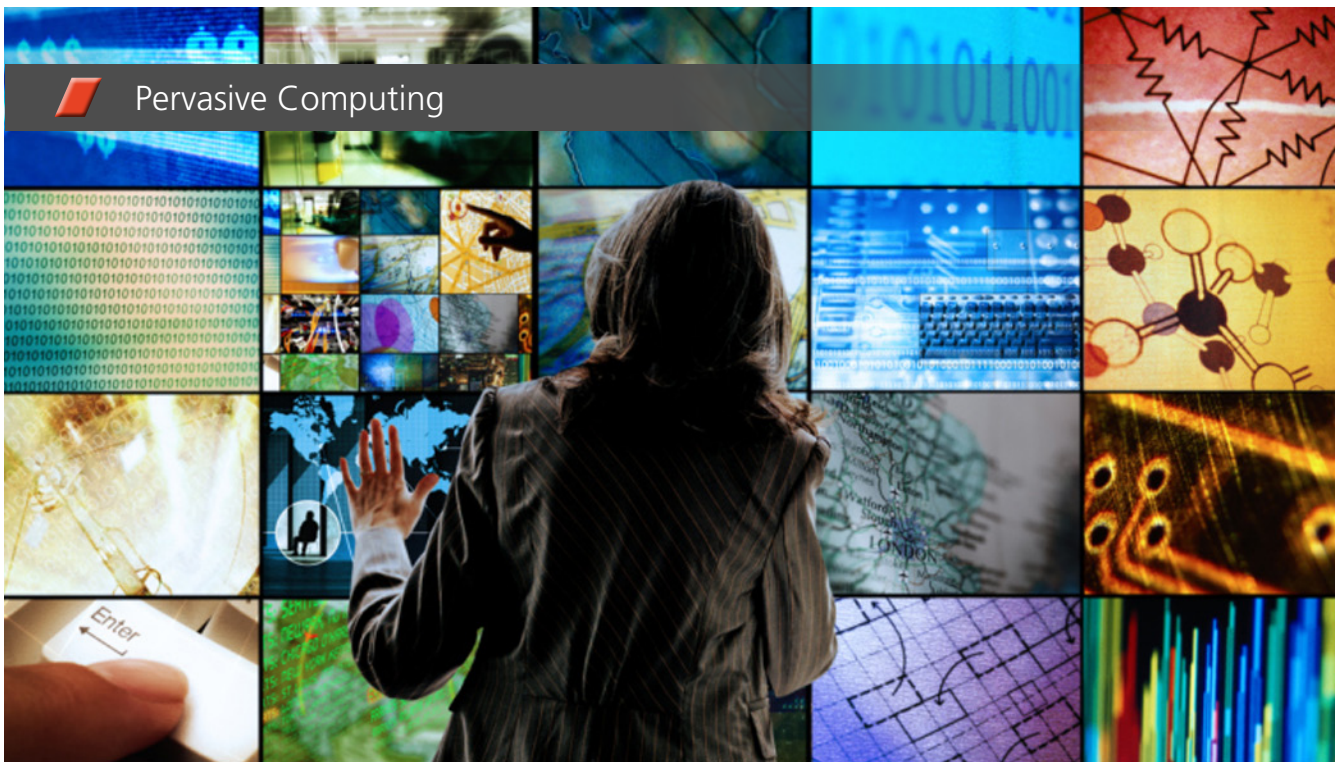
Pervasive or Ubiquitous Computing was first termed and popularized by Mark Weiser in his ground-breaking 1991 paper *The Computer for the 21st Century*¹. Mark Weiser's version of Pervasive Computing related to the creation of environments involving computing and communication capability, which seamlessly integrated with the end users. The initial thoughts on Pervasive Computing were considered well ahead of its time given the lack of hardware, software as well as networks to support this vision.

At Infosys, our vision of Pervasive Computing also focuses on the end user. There are now various technologies, devices and networks facilitating seamless computing, communication, collaboration as well as commerce related functionalities for the end users. This is made possible by embedding sensors, controllers, devices and data into the physical world thereby creating seamless interactions.

Pervasive computing is therefore ubiquitous, enabling everyday objects to become smarter and interactive such as refrigerators that can create grocery lists, automobiles that can inform service centers when they require any repairs or buildings that can adjust temperature and lighting according to the weather and number of people in the room. Pervasive Computing will therefore revolutionize the way humans interact with the world around them.



Pervasive Computing



Pervasive computing- key characteristics

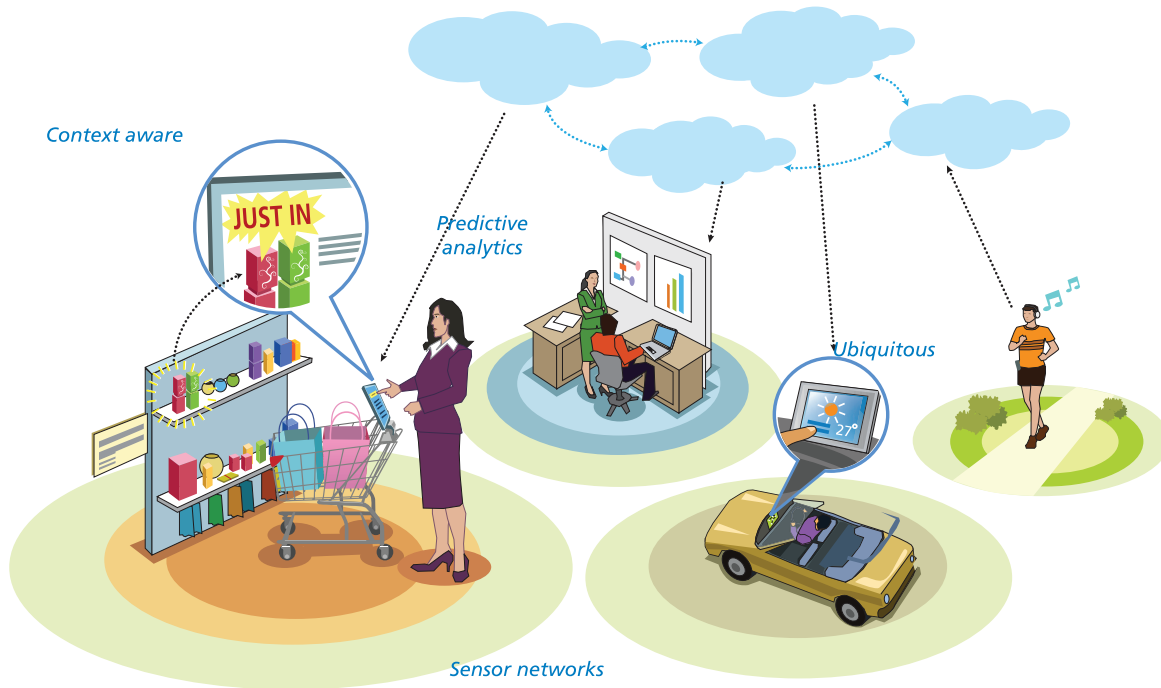
Pervasive computing is an integral component of building tomorrow's enterprises. By turning nearly everything into a computing device, pervasive computing is making it imperative for companies to reach their end-users through a multitude of devices — both wired and wireless. Users in turn are accessing content and applications through multiple channels as well as social networks, resulting in an exponential growth of data that needs to be constantly monitored and analyzed. Social networking platforms are engaging end-customers in an informal manner and the accumulated content and ideas become an aggregation of the collective intelligence of end-users. The popularity of Social Networking platforms is evident from the fact that globally, more than 750 million people around the world use Facebook² and Internet users are spending about 17% of their surfing time on social network and blogging sites.³

Intelligent enterprises are drawing inferences as well as key decision points by analyzing data from various sources about their customers, competitors, vendors, markets, products as well as services. Enterprises are able to garner localized, specific intelligence using sensor networks, thereby enabling them to develop innovative products and services, which are better aligned to market needs.

As computer technology progresses further, virtually everything, from the coffee mug to the human body, can be embedded with a chip or sensor that will record, store and provide data while integrating with other devices and networks in real time. Just in time computing and storage, using cloud based computing platforms and services are resulting in commoditization of infrastructure thereby enabling enterprises to better optimize computing and storage power. Infosys is leveraging these technologies to deliver lower Total Cost of Ownership (TCO), higher quality of service and better agility for our clients.

The core of Pervasive Computing

Intelligence, sensor networks and cloud based computing



Enterprises need to provide a seamless user experience across multiple access devices as well as multiple access networks. They need to effectively connect and engage end customers through different networks. Analysis of the vast amount of data collected through these networks allows organizations to study demographics of their users and cater to them accordingly. For instance, data shows that far more women than men are flocking to Twitter, Facebook, and MySpace⁴. Analysis of this particular customer segment for enterprises would enable them to improve their decision making by better understanding customer preferences. This can in turn be corroborated with insights from market research as well as data coming in from various customer touch points. Finally enterprises can optimize costs by leveraging and consuming just in time computing and storage via cloud based computing platforms and services. The three significant themes that will help in the evolution of pervasive computing are – Intelligence, Cloud based computing and Sensor networks.

Intelligent

The agility with which the supply chain is managed will ultimately determine the competitive advantage of enterprises. Intelligent technologies help in managing supply chain as a network of collaborating entities using the optimal mix of solutions involving information sharing, collaboration, optimization and transactions. This would involve not just setting up and managing an efficient and intelligent physical infrastructure for the flow of goods and services, but also facilitating efficient and intelligent flow of information across various supply chain entities. Artificial intelligence, multi-agents and fuzzy logic based techniques can be used to optimize the supply chain. Artificial intelligence techniques play an important role in technology investments as they allow enterprises to solve complex problems by leveraging intelligent agents. These intelligent agents understand the surrounding environmental attributes and adopt the optimal course of action. Artificial Intelligence techniques are used to solve problems in various scenarios. For instance, banks use artificial intelligence systems to understand underlying patterns in the stock market, stock market trading simulations etc. Retailers, Hospitals and Telecommunication service providers can adopt artificial intelligence to project customer acquisition, workforce management, staff rotation etc.

We are currently witnessing an exponential growth of data (both structured as well as unstructured). Emergence of social networks has resulted in the growth of unstructured data. The accumulated content and ideas within successful social networking environments thus becomes an aggregation of the collective intelligence of the user community participating in those sites. The accumulated collective intelligence can be considered as an asset that has value, which can be tapped through the right types of analyses. It presents significant opportunities for enterprises that wish to leverage social networks for insights and inferences on their users.

Enterprises can improve their decision making by better understanding and analysing the collective intelligence created across various customer touch points as well as social networks. This is facilitated by technological developments in areas such as customer intelligence, text analytics, semantic web, natural language processing as well as social network analysis. Enterprises can use web analytics to understand their customers and create a powerful feedback network and also an alternative sales channel. Some of the key enterprise challenges and opportunities from leveraging intelligent technologies are:

- Improved decision making through an understanding and analyses of the collective intelligence created across various customer touch points as well as social networks
- How to obtain intelligence from data created across various customer touchpoints and make effective and efficient decisions
- Effectively connect and engage end customers via formal as well as informal social computing and networks
- Better understanding of customer behavior using techniques such as text analytics, natural language processing as well as social network analysis
- Complex problem solving by leveraging Artificial intelligence techniques

Cloud based

Optimization of cost is pushing organizations to look at alternative models for acquiring IT related services. There is an ever increasing need for bringing in Innovative solutions with reduced time to market for delivery. Enterprises can optimize costs by leveraging and consuming just in time computing and storage via cloud based computing platforms and services. Cloud computing will help take ubiquitous computing to the next level with its ability to offer computing power anywhere, at any time and on any device.

Cloud computing provides a massive abstracted IT infrastructure, dynamic allocation, scaling, movement of applications as well as commoditization of infrastructure. Cloud based applications are delivered over the internet and the pricing is based on consumption (Per User, Per GB, Per CPU Hour). Cloud computing has advantages such as lower costs, faster time to market, high degree of flexibility, unlimited infrastructure growth capability,

low lock-in, low cost of entry and low incremental cost. Its advantages are being quickly recognized and the technology is being adopted rapidly. It is estimated that by 2012, 80 percent of Fortune 1000 enterprises will be paying for some cloud computing services, and 30 percent will be paying for cloud computing infrastructure services.⁵

Some of the typical requirements for using cloud computing include applications that require storage and archiving, social community based applications as well as non-business critical applications. Consider this scenario- an enterprise planning is launching a new online product worldwide in 30 days. The enterprise needs to make investments in time; effort and money to facilitate hosting and has to look into performance assurance, hardware, software, round the clock support and much more. Such scenarios are ideal for adopting Cloud Computing based solutions, which would enable the enterprise to pay only for the server resources, applications and bandwidth that they use.

Some of the key enterprise challenges as well as opportunities from leveraging cloud based technologies are:

- Optimization of costs by leveraging and consuming just in time computing and storage
- Launch of innovative solutions with reduced time to market for delivery, lower costs, reduced capex, pay as you use and high scalability
- Improved flexibility to scale up or scale down the business
- Improved reliability and better business redundancy by leveraging distributed data centers

Sensor Networks

Sensor networks include a network of nodes that can sense and may control the environment therefore enabling interaction between people or computers and the surrounding environment. The concept of Internet of things or the Internet of objects relates to the interconnected nature of objects and things. The building blocks of such systems are, adaptable sensor networks comprising of radio tags which are context-aware, can sense, monitor and report events. Sensors networks are wireless, self-powering, scalable as well as self-organizing.

Organizations are increasingly adopting Smart environments. These include Smart grids, Smart power systems, Smart housing, Smart transportation systems, Smart retail store etc. Smart environments collect sensor data from the real world, which comes from multiple sensors, which are distributed across locations.

Sensor Networks facilitate enterprises to sense and monitor a phenomenon remotely via sensor nodes and send the information to its peers or to the control unit. This is made possible by embedding sensors, controllers, devices and data into the physical world. By turning nearly everything into a computing device, pervasive computing is making it imperative for companies to reach their end-users through a multitude of devices. As computer technology progresses further, virtually everything can be embedded with a sensor that will record, store and provide data while integrating with other devices and networks in real time. Sensor networks are particularly useful in scenarios where monitoring is either not feasible or not cost effective.

Some of the key enterprise challenges and opportunities from leveraging intelligent technologies are:

- Improved decision making through enhanced information flow from distributed locations using sensor networks
- Improved visibility across the supply chain and real-time data availability for streamlined operations
- Connect and engage end customers accessing products and services via multitude of devices such as mobile, TV, sensors, appliances as well as via multitude of delivery channels such as wired/wireless internet, bluetooth etc.
- Better monitoring of production processes to optimize operations, reduce costs, enhance production as well as prevent and/or detect health and safety issues

Conclusion

Organizations require agility, flexibility, efficiency, innovation and cost-effectiveness to succeed in the future. Cloud-computing is helping cater to these requirements and changing the way organizations do business. For the enterprises of the future, IT based solutions could be the differentiator. So in this environment, we at Infosys believe that the question is how to adopt cloud technologies and what is the right approach to maximize business value from it. To address this need and to help organizations make the cloud adoption journey, Infosys functions as a Cloud ecosystem Integrator. As a Cloud ecosystem integrator, we offer enterprises single point accountability, rapid time-to-value and improved customer experience. Infosys Cloud+Services helps organizations orchestrate and integrate Cloud services with their existing enterprise investments. Infosys offers Industry-leading Services in the Cloud as well as Professional services for the Cloud.

Infosys is enabling clients adopt cutting edge technologies and stay ahead of the curve with the help of our innovation accelerators. These solutions which have been created at Infosys keeping in mind the future of enterprises help accelerate our clients' innovation journey. Currently, end users are embracing new technologies with ease and pervasive computing will take the human-computer interaction to the next level. Enterprises need to be prepared to provide a seamless user experience across devices and networks and connect with and engage their customers across platforms and formal and informal networks. Infosys' SONAR is an example of our innovation accelerators in this area. SONAR is a platform that combines social networking with augmented reality (AR) and can be rendered on multiple devices- desktops and mobile. SONAR can be customized for various industries, it creates an immersive experience and combines this with social networking. SONAR blends the real and virtual worlds and its possibilities are limitless.

References

1. <http://www.ubicomp.com/97806D6A-6D49-4286-8A3C-93300267364A/FinalDownload/DownloadId-04E2B7643064B35673EDD2BFE31CDD9E/97806D6A-6D49-4286-8A3C-93300267364A/want/papers/ubi-sciam-sep91.pdf>
 2. <http://www.facebook.com/press/info.php?statistics>
 3. http://blog.nielsen.com/nielsenwire/online_mobile/social-networking-and-blog-sites-capture-more-internet-time-and-advertisinga
Source: <http://www.fastcompany.com/blog/stephanie-schomer/write/more-women-use-social-networking-sites>
 4. <http://cloudxtension.com/2011/02/buzz/>
-



For more information, contact askus@infosys.com

About Infosys

Many of the world's most successful organizations rely on Infosys to deliver measurable business value. Infosys provides business consulting, technology, engineering and outsourcing services to help clients in over 30 countries build tomorrow's enterprise.

For more information about Infosys (NASDAQ:INFY), visit www.infosys.com.