

# LET THE CIRCLE BE UNBROKEN

How the "Information Circle" Created  
by Device Networking / M2M and the  
Internet Will Automate the Global  
Enterprise.

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A Harbor White Paper

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By the year 2010, the Internet will have trillions of users it doesn't have today. Most of them will not be human beings.

### A Digital Nervous System for Global Business

The Internet has been a profound driving force on the path to a truly connected world. Most people realized this the moment they sent their first email or saw their first Web site. Recall that America Online began as a completely closed, proprietary system. When the Web arrived, AOL did not permit its users to send or receive email from the Internet at large, or to browse Web-based content. The company tried to maintain this "island" status for quite a while, until it became apparent that *the sudden emergence of a global data network* was so monumentally important that survival demanded connectivity with it.

The entire tale of digital networking and its transformation of business and society is told in that small anecdote from the history of AOL. The early text-only Internet had been used for decades by the military and most academic institutions, but with its rapidly deployed public infrastructure, and then its graphical, mouse-driven Web interface, the Internet ushered in the 21st century just a hair ahead of schedule—around 1995—and the watchwords of the new age were clear: open standards, connectivity, global information-sharing.

The excitement that greeted the Web's arrival is the important thing to remember about the dot-com era, not the greed that inflated the famous bubble. Everyone knew instinctively that something truly epochal had arrived. Despite the boom-and-bust—and the venture capital ghost-town it left behind—the Internet has steadily continued to re-shape human communication and transactions.

But that's the point: *human* communication and transactions.

In the years since the "crash," the Internet has attracted many new users—including an entire generation of young people who can't remember a world without it—and the Web experience keeps getting better and better. Yet we have essentially remained in the dot-com era. Even now, most utilization of our glorious global *data* network is initiated by, or directed at, human beings. The many much-publicized initiatives

to “deliver broadband content” to Web browsers, PDAs, and mobile phones only continues this exclusively human-centric type of thinking. Yes, we can make “data” show itself directly to the human senses in the form of text, pictures, sounds, and video, but that’s a very small part of what can be done with open, global data processing and sharing.

The Internet’s most profound potential lies in its ability to connect trillions upon trillions of fast, smart sensors, devices, and ordinary products into a global “digital nervous system” that has been dreamed about by visionaries since at least the 1940s. It will completely automate most enterprise functions, allowing every type of business to achieve undreamed-of efficiency, optimization, and profitability.

### Let the devices do the talking

On that “path to a truly connected world,” Web sites and email—history-making and permanently useful though they are—were only the very first step. The next step will be vastly more profound, and will be based upon what is usually called “device networking” or “machine-to-machine” (M2M) messaging.

It seems ludicrous today that AOL could have thought for a moment that its users would remain satisfied to live on an electronic island, unconnected to the larger networked world. It will soon seem equally ludicrous that we once possessed countless smart devices whose intelligence was confined to their own enclosures.

For decades, we have been steadily building electronic intelligence into manufactured objects by means of sensors, controllers, and microprocessors. Today, virtually all products that use electricity—from toys and coffee makers to cars and medical diagnostics—possess inherent data-processing capability.

It thus follows that virtually all electronic and electro-mechanical products now contain a wealth of information about their status, usage, and performance. This information can offer extraordinary business advantage to the companies that manufacture and service those products, especially in terms of those companies’ relationship to their customers.

*The transmission, harvesting and interpretation of this device-based information as a basis for strategy and action will make every form of business dramatically more efficient and profitable than ever before.*



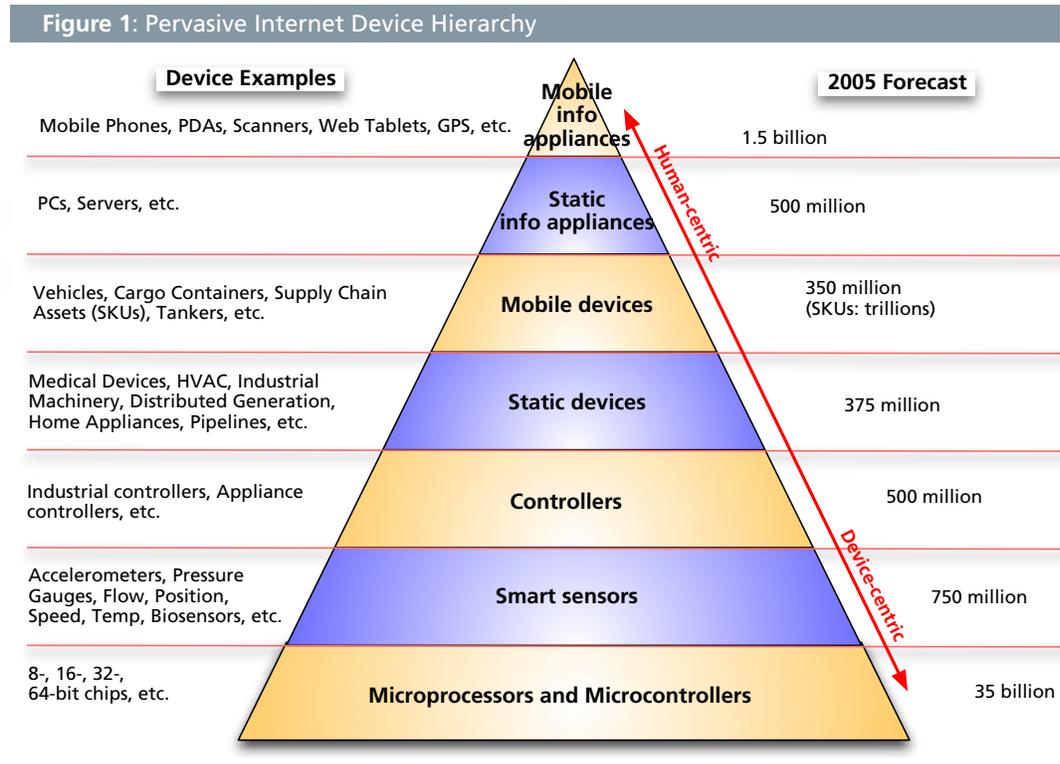
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Harbor Research calls this phenomenon “The Pervasive Internet”—the fusion of pervasive computing, Internet connectivity, and new enterprise-level data-management applications and Web-based smart services.

We call its effect on commerce and the enterprise “Invisible Business.”

**Device Growth & Scale Findings**

Our analysis indicates that by the end of 2003, 9.5 million devices (excluding PCs, phones, PDAs, any device under \$50 in value, and some other consumer information appliances) will be Internet-connected. This is a small fraction of the entire relevant device population, but the number promises to grow rapidly throughout the decade (see Figure 1).

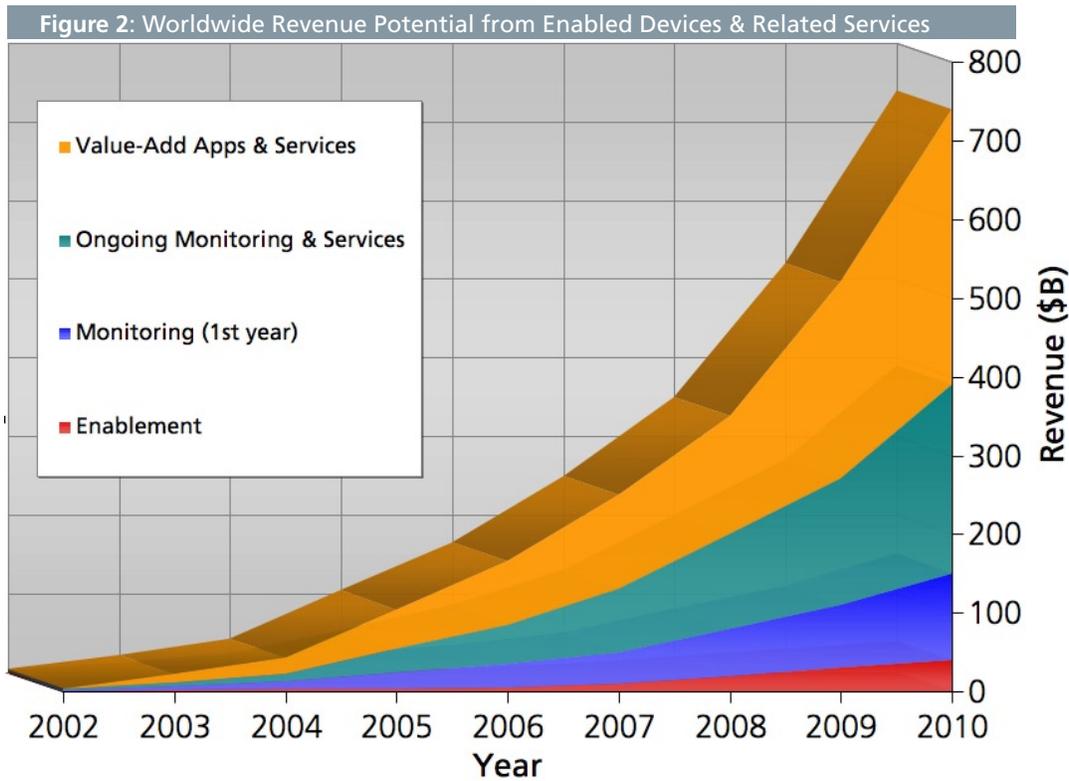


Source: Harbor Research, Inc.

Soon, any electronic or electro-mechanical device that is not networked will rapidly decrease in value, creating even greater pressure for devices to be online. Those organizations that increasingly network their devices will achieve a compounding value effect in proportion to the number of devices networked.

### Market Opportunity Findings

By 2010, a minimum of 1.5 billion devices will be Internet-connected worldwide. These devices will create a minimum \$700 billion total opportunity for the companies involved in enabling, monitoring, and providing value-added services for those devices. The largest opportunity will exist for value-added services companies, and enablement of devices will become a de facto part of most service or sales contracts (see Figure 2). As chips become faster, smarter, and cheaper, connected devices will blend into every environment, and vast opportunities will arise for companies managing and responding to the data being generated.



Source: Harbor Research, Inc.



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**It's official: the Pervasive Internet is here**

The technological roadblocks to the Pervasive Internet are now gone. Numerous innovators—many of whom Harbor works with directly—have solved the difficult “plumbing” issues of device connectivity.

If you're ready for “the automated enterprise,” the tools are here. Many of them are painlessly plug-and-play, designed for existing enterprise systems, and come with very attractive ROI.

Not surprisingly, the business-world roadblocks to the Pervasive Internet are coming down more slowly than the technological ones. The new capabilities will bend the traditional linear “value chain” into a loop of complex interdependencies that will demand new thinking and new alliances. But tangible real-world traction is occurring, thanks to a broad array of forces. Let's consider some examples.

**Retail, Supply Chain, and Business Logistics**

As we write, a remarkable story is unfolding with a tiny hero at its center: the radio frequency identification (RFID) tag, a microchip and transmitter smaller and thinner than a U.S. dime. The high-tech successor to the barcode, the RFID tag allows any object to wirelessly identify itself to “readers” that can be placed anywhere—at a loading dock, in a cargo plane or truck, on a store shelf. The reader sends all pertinent information about the object to an enterprise database: time, location, temperature, vibration, atmospheric pressure—anything that can be sensed and measured. The database can then report on everything about that object's movement and condition, as well as its relationship to other objects.

The result? 100% real-time visibility of the supply chain, with literally unlimited logistics and marketing possibilities. RFID promises to be one of the hottest Pervasive stories of 2003-2005, with these key recent developments:

- ▶ The **Auto-ID Center**, headquartered at MIT with over 90 corporate sponsors, has spent years developing standards, software infrastructure, and business alliances to bring about “an Internet of things.” At the heart of this work is the **EPC™** (Electronic Product Code), a uniform specification for how objects identify themselves to the network. RFID had already been used to track large containers and palettes of

goods, but remained too expensive and logistically complex to deploy at the retail item level. The Auto-ID Center's EPC™ Network changes all that.

- ▶ In May, 2003, the creators of the barcode—the United States's **UCC** (Uniform Code Council) and its European equivalent **EAN** (European Article Numbering)—announced the formation of **AutoID, Inc.**, a non-profit organization to which the Auto-ID Center granted an exclusive license for its EPC™ technologies.
- ▶ In June, 2003, **Wal-Mart**—an Auto-ID Center member—announced that it would place EPC™ tags on every retail item by the year 2005. Real-world EPC™ trials had been conducted before (notably by Gillette, another Auto-ID Center member), but Wal-Mart's decision represents a futuristic quantum leap. The retailer's tags will generate a terabyte (1,000 gigabytes) of device data per day, all managed by AutoID, Inc.'s **Savant™** data-management technology. Wal-Mart is not only the largest retailer in the U.S., but is widely viewed as the smartest and most innovative—in the U.S., and perhaps the world. When Wal-Mart leads, others quickly follow.
- ▶ On the very same day that Wal-Mart made its historic announcement, **Microsoft** jumped on board with a statement embracing AutoID, Inc.'s technology and vowing cooperation.

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### Connectivity and IT

There's a great secret to 21<sup>st</sup>-century business, which we will now give you, absolutely free, in the form of a little poem:

If you want people to come in your store,  
Don't charge them to open the door.



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For a comparatively brief historical period, access and IT providers made billions by essentially charging people to open the door. Well, those were the days when the “door” was being created, and you could get away with that.

Those days are now over.

Telcos, wireless networks, and other connectivity/access providers are presently suffocating under mountains of debt incurred during the massive infrastructure build-out of the dot-com era. Alongside them, the large IT providers are suffering steadily declining profits and lackluster interest in their latest offerings. Each year, people expect to pay less, not more, to open the door. Eventually, they won't want to pay at all. What they will pay for, however, is the value of genuinely innovative goods in the store. Those goods take the form of new services based upon fantastically sophisticated analysis of the data coming out of the connected economy. As the old door-owning giants lie dying, the shimmering image of the 21<sup>st</sup>-century smart-services store glows just outside their blinders.

- ▶ Connectivity providers remain a remarkably human-centric community. If a device does not have a screen for a person to look at (TV, computer, PDA, mobile phone), they don't care about it. But human-centric services are a saturated market. There are simply not enough people to buy enough eyeball-oriented connectivity and “content” to bring these providers back to fiscal health.

Meanwhile, trillions upon trillions of non-human Internet “users” wait for network access that doesn't exist. Smaller players who understand the profound opportunities of machine-to-machine (M2M) “device networking” will soon pull an end-run around the dinosaurs—unless the dinosaurs wake up in time. Happily, events such as the Wal-Mart and Microsoft RFID announcements noted above are likely to ring the alarm. Right now, large connectivity providers need to forge new business plans and alliances to bring access to “embedded” devices that do not require human attention or intervention.

- ▶ But that's just the beginning. Access is not valuable unless it leads to something. Connectivity provisioning is rapidly becoming a commoditized, declining-profit business, and this will apply to device connectivity, too. Likewise, open-source software and ever-cheaper hardware are commoditizing the server-farms that were once the bread-and-butter of IBM, Sun, Cisco, et. al.

While basic device connectivity is essential, and holds undoubted first-mover advantages, the literal hook-up is merely “the door.” Trusted providers such as telcos and the large IT and wireless entities now have the opportunity to create “the store,” and stock it with vital, never-before-seen services that capture and leverage the business value of connected device data. If you're a provider, the question is “where's my future revenue coming from?” If your answer is simply “bits,” you're on the path to the tar-pits. Bits are the door.

- ▶ Nokia, a global innovator, is spearheading its own “M2M” program to make its mobile phones truly “connected devices.” You already know why mobile phones are given away free. The phone is the door.
- ▶ Cisco, surprised by the home/SOHO networking and Wi-Fi explosion, has purchased LinkSys, the leading producer of the consumer devices that enabled that phenomenon.
- ▶ AT&T, Intel, IBM, and Apax Partners, blindsided by the wireless “guerilla networking” phenomenon in major cities, have formed Cometa Networks to offer national wireless Internet access based upon what was formerly seen as an insignificant “consumer” technology—Wi-Fi (802.11).
- ▶ The “ZigBee” phenomenon promises to propel short-range wireless device networking into common use at warp speed. ZigBee is the popular term for the 802.15.4 RF standard, a cousin of the 802.11 standard called “Wi-Fi” that is now



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commonly used for laptop connectivity in the home and in “hotspots” such as airports and coffee shops. Where Wi-Fi is used for human-oriented products, ZigBee is used for direct machine-to-machine (M2M) communication. It has device-specific advantages over Wi-Fi, Bluetooth, and other forms of wireless connectivity—in particular, very low power consumption, which means long battery life. Wireless device networking has been waiting for a connectivity standard, and ZigBee fills that need. To get an idea of the momentum, consider that the ZigBee Alliance, a consortium of supplier and adopter companies, now reports an average of two new corporate memberships every week.

- ▶ Oracle’s Larry Ellison “shocked” the IT world with a hostile takeover bid for PeopleSoft. In fact, the only shocking thing is IT’s shock. Oracle is simply acknowledging that database systems, like other pieces of IT and connectivity, will soon be mere commodities. Future growth lies in new forms of data analysis, knowledge management, and super-smart business services—things that Oracle has not done particularly well. Oracle has the door, PeopleSoft has the goods for the store. Oracle wants PeopleSoft. Simple. Not shocking.
- ▶ The SCO Group similarly shocked the IT world by alleging that Linux—the open-source OS juggernaut that now underlies major initiatives from Nokia, Motorola, IBM, Sun, and many other leading companies—violates its patents. SCO clearly realizes that operating systems are also becoming commodities of the digital age. *This is evolution, and cannot be stopped.* When it comes to core enablement, “open” trumps proprietary every time, and you can take that to the bank. Whatever the specific merits of the case, SCO is throwing litigation at a global tidal wave. A better response might be to *ride that wave* with the things that aren’t so easily commoditized: smart services for 21<sup>st</sup> century business.

## Homeland Security and Government

On September 11, 2001, the whole world had a horrible wake-up call. When we sat up in bed, the nightmare was real. Our immediate response was understandable and—in the very short term—even proper.

We mustered brute force.

Armed personnel appeared in airports and public facilities. Travellers were searched down to the insides of their shoes. Cockpit doors were bolted shut, and all manner of physical obstacles to terrorism were erected—including such things as concrete barriers in Baltimore’s Inner Harbor to stop bomb-bearing speedboats.

But brute force is a blunt instrument, and it’s not cheap. Nor is it fast, intelligent, or particularly efficient. In the end, brute force can’t keep us safe. The world is too complicated and interwoven now for that. The Department of Homeland Security and its related agencies know this. In the most sensitive settings, “smart security” technologies are already in place, and the agencies are quickly exploring high-tech measures for more ordinary locations.

Every single supplier of device-networking / M2M products, systems, and services possesses technology potentially relevant to security, whether it was originally envisioned for security or not. All suppliers should be re-telling their story in relation to homeland. Some have already done so, most have not.

Security measures from the world of pervasive computing that were futuristic and expensive just a few years ago are a reasonable proposition today:

- ▶ “Smart building” technologies that monitor and self-regulate every sub-system of a facility in real time.
- ▶ RFID and other wireless tracking tags for personnel and physical assets, including “wearable” and fabric-based computing.
- ▶ Biometric identification of visitors to a facility, including real-time analysis of fingerprint images, retinal scans, facial-structure data, and networked surveillance-camera video.
- ▶ Sensor and sonar networks in bodies of water.



## Energy and Power

As we write, summertime is beginning in America. The swallows are coming back to Capistrano, and the rolling blackouts are coming back to L.A.

If they ever want to make yet another “Dumb and Dumber” movie, the United States power grid could be the star. Energy Secretary Bill Richardson, quoted in the June 11, 2000 *Wall Street Journal*, said: “The U.S. is a superpower, but it has the grid of a Third World country.”

The simplest window air-conditioner is full of microprocessors, but—you guessed it—it’s not networkable. If it were, the manufacturer could easily make it programmable, so that you could say, “I want this room to be X degrees if I can get the power for Y price, otherwise I want the room to be Z degrees.” But for that to work, the grid itself would have to be smart enough to communicate with the AC unit, and the grid isn’t. In most parts of the United States, the grid isn’t smart enough to keep itself from going down.

But there’s good news. Like the other business sectors discussed in this paper, Power has reached the “tipping point.” The following are some of the drivers that will cause fast adoption of Smart Energy solutions:

- ▶ Volatile energy prices, painful strain on infrastructure, and power quality too poor for the digital economy have created the need for a transformed energy market.
- ▶ Deregulation, despite recent setbacks, has opened the energy market to new technologies and device networking solutions that would not have thrived in a regulated market environment.
- ▶ Device networking technology exists today that can help improve power production, distribution and usage. Years of engineering developments have resulted in affordable technology solutions that, connected by the Internet, can help lower power costs and increase its efficient use.
- ▶ New services have emerged that have quickly changed how utilities can increase revenues, and how consumers of power can better manage costs. These new services will

rely on networked power devices that can be automatically monitored, controlled and managed to adjust to power cost, availability, and usage requirements.

- ▶ The market for developing and servicing device networking and monitoring solutions is still quite open and fragmented. Opportunities abound in the hardware, software, networking and services spaces. Our research indicates that 285+ million devices are presently available for networking in the power industry, representing several billion dollars of revenue opportunities for suppliers. And that's just today.

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### **Smart Healthcare, Smart Industrial, Smart Vehicles, Smart Everything**

A detailed discussion of Pervasive Internet developments in every vertical market (at Harbor, we call them “venues”) is beyond the scope of this paper. Suffice it to say that every business imaginable will be quickly transformed by the breakthrough activity now occurring in the Pervasive Internet (see Figure 3). That transformation will require new investment, new business models, new alliances, and new imagination. Its reward will be unprecedented efficiency and profitability.

Those who fail to make the transformation will no longer be here.

### **Conclusion: The Information Age—for real this time**

We've been living in “the Information Age” for a long time now. At least that's what we keep telling ourselves. It would be more accurate to say that we've spent the last several decades in the lobby of the Information Skyscraper, waiting for the elevator.

With the sudden availability of global public Internet access in the late 1990s, the elevator arrived and opened its doors. Now we have to get on.

Call it what you will: the Pervasive Internet, pervasive computing, ubiquitous computing, network computing, device networking, machine-to-machine (M2M) messaging, sensor networks. In the end, it all means the same thing: *an unbroken circle of information* from the beginning to the end of all product life-cycles, all business processes, all customer relations.



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Everyone agrees that information is power. To date, business has had the sketchiest of information about its own goings on—partial pictures, isolated snapshots, fleeting, blurry, outdated glimpses.

We have now entered the age when everyday objects will communicate with, and control, other objects over a global data network—24/7/365, without human attention or intervention. That network is the Internet. The objects are everything from consumer appliances to the elevator you’ve been waiting for. It’s not “the future,” it’s now—this year, next year—and thus it is vitally important that business leaders understand this phenomenon, its effects on their business, and what they should do right now to position themselves for things that are literally just around the corner:

- ▶ Manufacturing and farming equipment, elevators and escalators, appliances and vehicles that know exactly when and why they will fail, and then alert you or your service organization before the failure occurs—or even, in some cases, fix themselves.
- ▶ Buildings and facilities with “digital nervous systems” that ensure occupant comfort and safety, and even enhance productivity.
- ▶ Retailers and distributors who know exactly where every piece of inventory is at any moment, and under what conditions it arrived.
- ▶ Industrial power customers who save a fortune on energy by being able to see, in real time, exactly how they’re using it.
- ▶ OEMs that are not “disintermediated” at the point of sale, but stay connected to end-customers via a steady stream of status/usage/performance data from their connected products, thus able to offer profitable after-market services and to engage in smart marketing that isn’t a shot-in-the-dark waste of money.
- ▶ Healthcare facilities where accurate, up-to-the-minute patient information is always available because every piece of

medical equipment, from digital thermometers to life-support machines, is networked and associated with a patient ID.

- ▶ Medical implants that doctors can monitor remotely in real-time, no matter where the patient is.

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And on, and on, and on. Science fiction? Not anymore.

At the end of the day, all business is about delivering honest value and making a profit because you're smart and your customers are happy. When your customers send you an unbroken stream of information without anyone needing to lift a finger, you're *really* smart. When you base your business decisions upon that information, your customers are *really* happy. The term "feedback loop" was coined for it long ago. We like to call it an "information circle."

The phenomenon we've been discussing offers any enterprise nearly perfect real-time, real-world information, with short-term ROI and long-term advantages too numerous to name. That's the Pervasive Internet value proposition.

Business is a circle that spins with information.

Let the circle be unbroken. ◀



**About Harbor Research, Inc.**

Harbor Research Inc. has been providing strategic consulting and research services to leaders in communications, computing, control, and content since 1983. The firm has built extended relationships with larger multi-line companies including AT&T, ABB, General Electric, Danaher, Eaton, Emerson, Hewlett Packard, Honeywell, Hughes, IBM, Intel, Invensys, Lucent, Motorola, Rockwell, Siemens, and Texas Instruments, as well as focused growth companies such as EMC, Cadence Design, PRI Automation, Conexant, Qualcomm, SAP, and PTC.

We also continue to work for a broad array of emergent start-ups and pre-IPO technology ventures. We have built relationships with a number of significant Pervasive Internet players, including Qestra Corporation, Xsilogy, DataSweep, eDevice, Wireless Innovation, emWare, and Industrial Objects, to name a few.

Harbor is organized around emergent and disruptive opportunities in high technology, with a unique focus on the impact of the Pervasive Internet—the use of the Internet to accomplish global device networking that will revolutionize business by unleashing entirely new modes of system optimization, customer relationships, and service delivery.

**Contact**

Glen Allmendinger, President  
Harbor Research, Inc.  
gallmendinger@harborresearch.com  
800.595.9368 ext. 24  
415.615.9400 ext. 24 (outside U.S.)  
fax: 415.615.0454

