



From the Editor in Chief

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Global Perspectives

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Examples of the major emerging economies of the world include Brazil, Russia, India, and China. Although we expect pervasive computing to improve the lives and work practices of people in the developed economies in the short term, it's likely to have significantly more impact on the emerging economies where prior investment in technology has been lower.

THE IMPACT: DEVELOPED VS. EMERGING ECONOMIES

Developed economies already benefit from a bewildering array of computational infrastructure, which is being progressively integrated into work and recreational activities. The same technologies let corporations operate globally and produce cost-effective products and services. Kofi Annan, in his 2002 address to the United Nations, observed: "The new information and communication technologies are among the driving forces of globalization. They are bringing people together and bringing decision-makers unprecedented new tools for development" (see www.un.org/News/Press/docs/2002/sg-5nov-2002.htm).

However, in general, the populations of the emerging economies, representing about five-sixths of the world's population, have yet to realize the same daily

informational and computational benefits as the fully industrialized economies. Personal information technology can change all this. Compared to other economic catalysts—such as civil engineering—it requires a relatively small investment and can more rapidly be delivered to emerging areas of the world. When combined with Internet-based communication, portable computers can bring global expertise to regions with limited access to information. Similar to the computing explosion that desktop PCs caused in industrialized nations, investment in pervasive computing can begin to bridge the gap between the developed and emerging economies in a way that more traditional forms of computing (desktop PCs) can't.

This potential for another computing explosion partly exists because the emerging economies aren't encumbered by the legacy of older technology. Consider, for example, telecommunications. For an emerging economy that needs to build a communication infrastructure, laying telephone cables won't be as rapid or cost-effective as installing a cellular network. In some developed economies, particularly in the US, large-scale cell phone adoption was relatively late—ironic for a country that enjoyed the fruits of Alexander Graham Bell's first wired telephone system. The wired infrastructure's pervasiveness and pub-

lic call boxes' high availability (I even found one at the base of the Grand Canyon) helped delay the evolution of a more modern wireless capability. Emerging economies have the enviable benefits of starting from scratch using expert knowledge and of fully exploiting state-of-the-art technology.

However, a disadvantage of using the latest technology in emerging economies is that the design criteria for modern electronic products are based on the industrialized nations' prevailing environmental conditions. In many emerging economies, a stable electrical power source isn't guaranteed, and blackouts and brownouts are common. Also, the physical environment might expose equipment to extreme temperatures and thick airborne dust (see "The Challenges of Technology Research for Developing Regions" in this issue). Depending on the region, deploying computer systems might exceed the original design's limitations, resulting in faults and possible system failures. These issues remain a challenge in the world's more extreme regions.

Furthermore, although the emerging economies are growing rapidly, individual wealth is still not commensurate with the developed world, and information technology is still out of many people's reach. Philanthropists have suggested that industrialized countries should find

MISSION STATEMENT: *IEEE Pervasive Computing* is a catalyst for advancing research and practice in mobile and ubiquitous computing. It is the premier publishing forum for peer-reviewed articles, industry news, surveys, and tutorials for a broad, multidisciplinary community.

ways to eliminate this disparity, reducing investment costs and empowering more of the world's population.

The MIT Media Lab and Nicolas Negroponte have been active in formulating this challenge and have worked with industry to build a personal computer that turns this rhetoric into a reality. The novel PC design replaces a disk with flash memory, the LCD with an e-ink display, and runs Linux instead of Windows, reducing both hardware and software costs. It also employs a hand crank to recharge its batteries and supplement external power. The device is expected to retail at under \$100, with a target production date of 2007. This project has been a significant initial foray toward a worthy cause, and I'm certain it will be just the first of many exemplary projects in this space. (See, for example, this issue's interview with Raj Reddy on page 40.)

A NEW PERSPECTIVE: MY JOURNEY TO CHINA

Last year, I had the good fortune to visit China, one of the fastest-growing emerging economies. The major cities, Beijing and Shanghai, are experiencing considerable growth, and new construction and state-of-the-art technologies are commonplace. Shanghai will soon be able to boast the world's tallest building and already has the fastest bullet train (287 mph). My impression is that in their rush to modernize, there is great potential for the region to exploit the latest ideas in the field of pervasive computing.

During my stay, I saw people embracing all forms of pervasive gadgetry—from cell phones to the extensively deployed public flat-panel displays. In fact, I remember noting that a small store near the Temple of Heaven in Beijing was advertising not film or batteries but rather memory cards to supplement your digital camera's memory. Also, Beijing's city markets offered an amazing variety of technology, all at bargain prices. I saw not only the latest digital cameras, phones, PDAs, and computers but also designs I'd never seen in the US.

Perhaps major technology developers are testing some of their products solely in the Asian market, indicating that emerging economies might one day be the primary testing ground for innovative pervasive technologies.

While exploring the city, I also noticed that the city markets offered many pirated products based on commercial intellectual property such as software and DVDs. Clearly, the gen-

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eral expectations about the use of copyright materials are different in China than in Europe and the US, something that needs to change if entrepreneurs are to successfully capitalize on information technologies.

Another thing that became apparent during my travels throughout China was how well my US Blackberry worked. I was able to receive email from colleagues even while in remote places. For example, I had always wanted to see the Great Wall, one of the wonders of the world, and an unscheduled weekend provided the perfect opportunity to join an excursion. As we drove north from my hotel in the center of Beijing, I was pleasantly surprised to find my Blackberry fully operational all the way to the Badaling site, where the Wall snakes up and down the hills. Even at the Great Wall's highest point, I could still send email and phone home (waking the entire household owing to a time zone miscalculation). The following week, my next major destination was our corporate site in Shanghai, where I experienced similar ubiquitous access to the cellular network. The GSM/GPRS (General Packet Radio Service) network clearly is extensively deployed in and around China's major cities, a wise investment that puts their

businesses on a competitive communication footing with those of the developed economies.

One downside I contemplated though was the effect of rapid growth. I believe I'm quite fortunate to have taken numerous taxi rides in Beijing and still been able to write this article. The road traffic was intense and the drivers seemed overly competitive. I had to relearn how to walk across the street, as rapidly moving cars and crowds of pedestrians merged perilously. One of my guides offered this explanation: Between 2000 and 2005, Beijing's population grew from 13.8 million to 15.2 million, and the number of cars grew from 1 million to 2.6 million. Privately owned cars have actually tripled, and the number of vehicles in the city is now increasing by nearly 1,000 cars per day. Such growth has provided little time for a balanced driving etiquette to evolve. Might the same be true for the application of pervasive computing technology? Rapid deployment will likely shape the social rules governing pervasive computing's use, expression, and privacy implications. This is in contrast to the more steady introduction of computer technologies in the US since the desktop PC of the early '80s.

Emerging economies provide an opportunity to both test and benefit from novel pervasive computing technologies. Yet, at the same time, they present unique challenges. Ideally, emerging wealth should be distributed more evenly. Information technology can provide access to knowledge, education, and health services to help remove this disparity and break the cycle of poverty where governments aren't doing enough. Our research community is pushing the limits of mobile and ubiquitous computing, and some groups are already focusing beyond US and European work practices. Great opportunities exist in the world's emerging economies, and if you're not currently considering them, taking a global perspective could benefit you and your potential new customers. ■