By those means, Reliance already is offering customers limited-mobility cellular services in 680 cities and towns. The handset it gives customers, made by the South Korean companies LG Electronics and Samsung, doubles as a modem. Optimized for fixed wireless, it can also be used as a mobile instrument, though it must rely on different phone numbers when roaming far from home.

A fly in the ointment?

India's cellphone customers are a pampered lot, with 11 companies vying to serve them [see table, left]. Except for Reliance and one other, the state-owned BSNL, which also has opted for CDMA, the rest rely mainly on Europe's GSM standard.

Qualcomm's fortunes in India seem to be riding heavily on Reliance's business plan, though the California company has backed off from making a US $200 million investment it once said it might make in the Indian firm.

The major difficulty facing Reliance is that India's other cellphone operators are seeking to block the plan altogether or at least force its big-pocketed parent to cough up the same licensing fees they paid. A tribunal is expected to rule in the matter this month, whereupon the loser will appeal the decision to India's highest court.

However that plays out, Qualcomm founder and CEO Irwin Jacobs told investors in New York City on 22 May that he expected India to be a major source of revenue. He said there will be six million Indian CDMA users by the end of this year—echoing the exact number Reliance was bandying about earlier in the year.

Other Indian companies also are pursuing the limited-mobility option, notably Tata Teleservices Ltd. and Mahahnagar Telephone Nigam Ltd.

David Koilpillai, a wireless expert at the India Institute of Technology in Chennai (Madras), believes the new CDMA technology will eventually have an edge over GSM in terms of cost-effectiveness. Much of India's GSM infrastructure was laid around 1997 and now would have to be upgraded for GSM's General Packet Radio Service (GPRS), a so-called 2.5-generation stepping stone to full-fledged third-generation cellular technology. Newly deployed CDMA technology will have similar capabilities by definition. **—Seema Singh**

ROBIN SCHOLZ

Supercheap Supercomputer

Illinois researchers make US $50 000 cluster from Sony Playstations and off-the-shelf software

COMPUTING • The same hardware that lets millions of gamers race cars or battle giants may soon allow physicists to probe the foundations of reality. Researchers at the National Center for Supercomputing Applications and the computer science department at the University of Illinois in Urbana-Champaign have created a cluster of Sony Playstation 2 game consoles [photo] for just US $50 0000, hijacking specialized graphics hardware for scientific supercomputing.

One of the researchers, Mike Showerman, explains why the Playstation 2 had caught their eye after Sony Corp. released a Linux kit for the console last year. "We saw a potential at such a low cost that we decided that it was just something that we should be playing around with," Showerman told *IEEE Spectrum*. With the kit, users can install the popular Linux open-source operating system, turning each console into a general-purpose, network-ready computer. So, the researchers used the kit to network the consoles together and, more importantly, get access to each Playstation's sophisticated graphics hardware. This can process as many as 66 million polygons a second, which is what allows the Playstation to render realistic 3-D worlds so well. For mathematical reasons, each polygon vertex is represented as a vector, an array of numbers with four elements that represent positional information. At the heart of the Playstation's graphics hardware is a pair of "vector units"—dedicated arithmetic processors designed to operate on vectors.

"You can use them for generalized matrix-matrix and matrix-vector calculations by building up software libraries" from the arithmetic performed on the four-term vectors, says Craig Steffen, another researcher on the project. Many scientific problems are tackled using vectors and matrices.

Developing these libraries is the main focus of the current research. Ultimately, it would allow specialized physics software for things like quantum chromodynamics computation to run on the cluster by replacing normal mathematical software libraries with software libraries designed for the graphics hardware. But there are a number of obstacles. One is the problem of developing a more efficient way to move data in and out of the vector units. "We're going to have to see what tricks we can play with the hardware," says Steffen. Another is that the vector units do not fully comply with IEEE 754, the standard for hardware computation of floating-point arithmetic.

Mike Showerman [top] and Craig Steffen pose with the supercomputer cluster they built from Sony Playstation 2 consoles.

Ultimately, the purpose of the university's Playstation 2 effort is to prepare for the 2005 release of the Playstation 3. The hope is that if useful scientific computation can be demonstrated on the current system, there will be a road map for the Playstation 3, which will feature even more powerful graphics hardware, still at a fraction of a PC's cost. **—Stephen Cass**