Voices

"Search already is the spade by which we turn the soil of human knowledge. It's not 'the Web OS,' but it is our mainstream navigation interface."

John Battelle, founder of the *Industry Standard*, p. 81

"In the name of preserving morality, the president's decision has ended up creating moral anarchy."

Children's Hospital Boston researcher Mathew "Willy" Lensch, on President Bush's stem-cell policy, p. 46

"If one utility was to step out [and propose a nuclear plant], they could become the lightning rod for the antinuclear community, and for people's concerns on Wall Street."

Dan R. Keuter, Entergy's vice president for nuclear-business development, p. 40

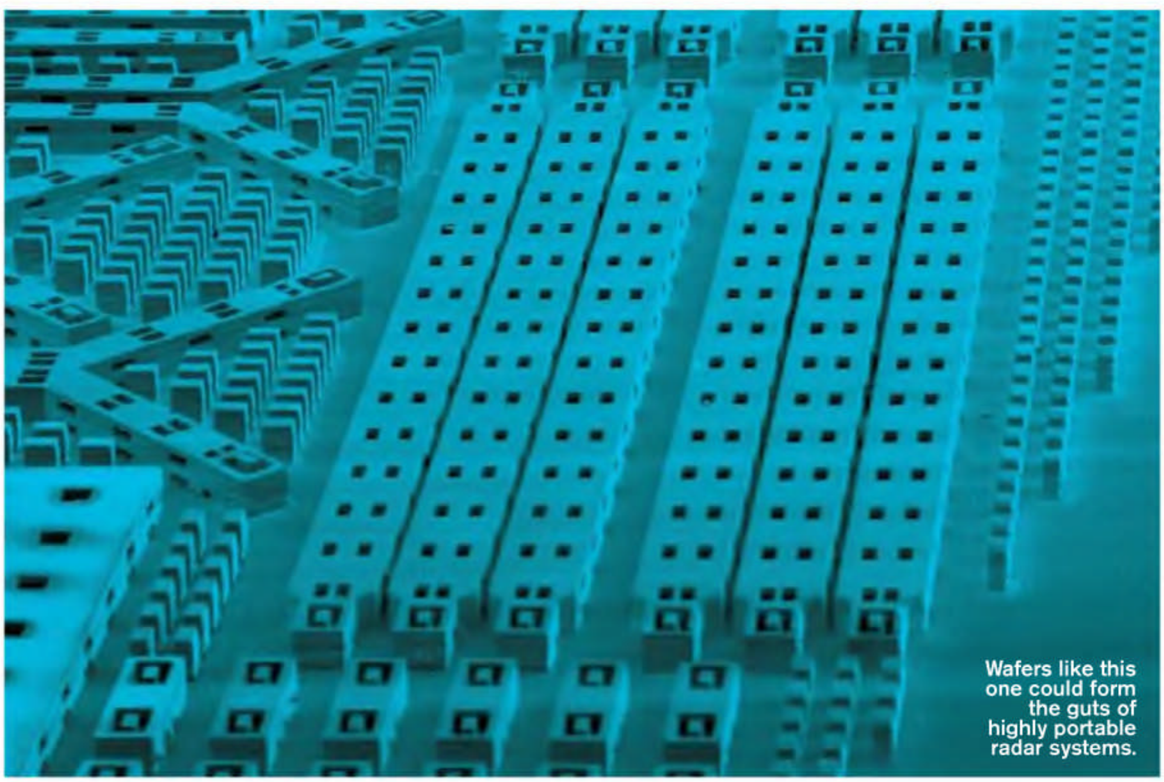
HARDWARE

Radio Communications

Fabrication tricks promise handheld radar

SECURE WIRELESS-COMMUNICATIONS systems and sophisticated radar have transformed warfare. But manufacturing them is costly and time consuming: the delicate radio components must be connected manually, increasing the systems' size and decreasing their reliability. In an effort to make such systems smaller, cheaper, and more dependable–for example, shrinking a TV-size military radio down to walkie-talkie size–military contractors are developing a sort of "circuit board" into which designers could simply plug radio components, much as engineers lay out chips on computers' familiar green motherboards.

Many radar and radio communications systems under development use millimeter-wavelength transmissions; such systems enable long-range communications and image resolution high enough to let soldiers easily discern whether a potential enemy is concealing a gun or bomb. While some millimeter-wave systems are already in use, they are too bulky and expensive for widespread deployment. "Ideally, you would like to be able to have things like a millimeter-wave radar on every Humvee," says Ezekiel Kruglick, a consultant for the U.S. Defense Advanced Research Projects Agency



Wafers like this one could form the guts of highly portable radar systems.

COURTESY OF MARIANNE MURPHY/BAE SYSTEMS

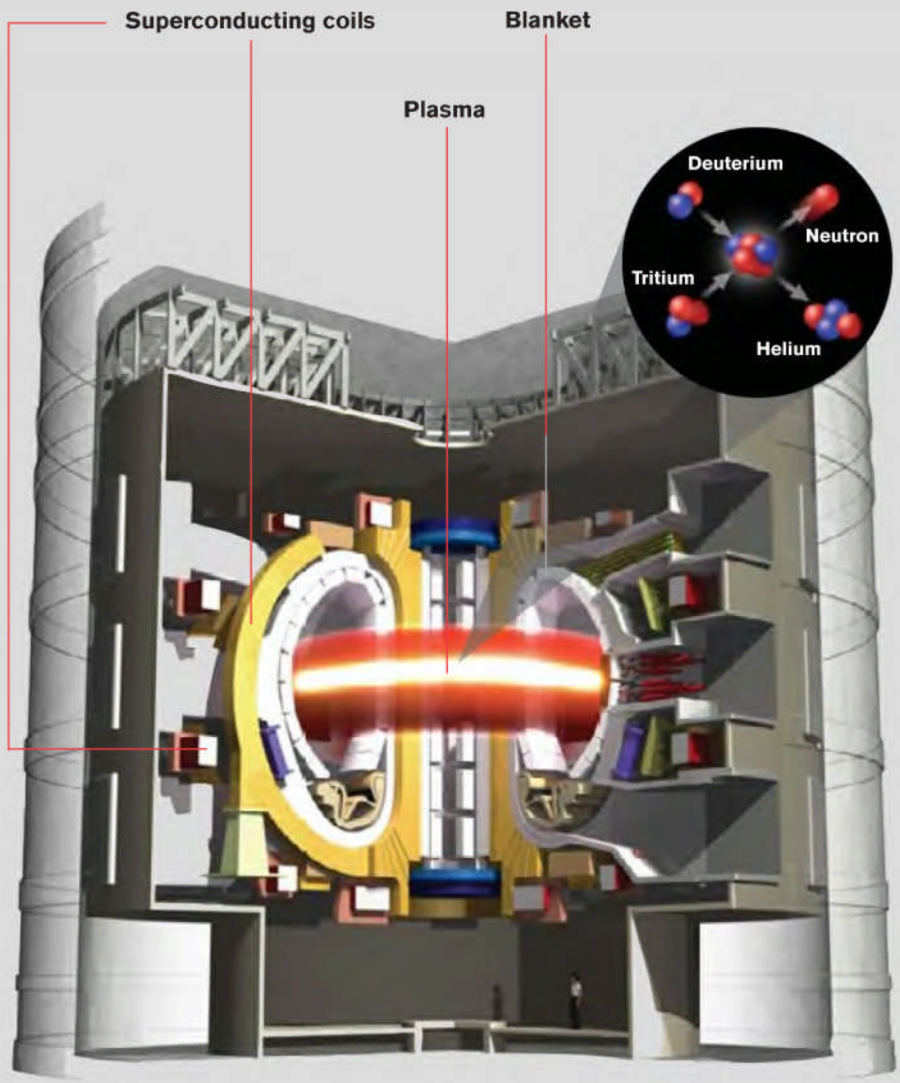
(DARPA). But routing the radio waves between the components of such a system requires custom-built channels or tubes. "Currently, [millimeter-wave] systems often look more like plumbing gone mad than high-tech electronics," says John D. Evans, a program manager for DARPA's Microsystems Technology Office.

As part of a DARPA project, BAE Systems and Rohm and Haas have developed a process that allows them to cheaply produce the radio frequency equivalents of circuit boards. The process uses a unique photoresist, a light-sensitive material similar to those used in semiconductor fabrication but 50 to 100 times as thick, to build the three-dimensional metal structures needed to connect millimeter-wave radio components. These circuit-board analogues are expected to decrease the size of radio and radar systems to one-twentieth of what they are today. They could also lower the cost of today's multimillion-dollar systems by as much as 99 percent and enable new applications, such as active defense systems that would calculate the trajectories of incoming mortar shells and launch countermeasures to intercept them.

"Currently, [millimeter-wave] systems often look more like plumbing gone mad than high-tech electronics."

Radio-frequency circuit boards could eventually work their way into a variety of consumer applications as well. They could, say, bring down the cost of active cruise-control systems, which can detect other cars and brake automatically. And the same manufacturing process could also allow the mass production of tiny vacuum electronic devices. These could enable, for instance, satellite-based TV and Internet access for moving vehicles.

BAE is on schedule to build demonstration systems using the new radio-frequency circuit boards by the end of 2007. Before the decade has ended, the technology could yield cutting-edge collision-avoidance radars, as well as high-bandwidth data, voice, and video satellite communications cheap enough for most cars. **Erika Jonietz**



ENERGY

Fusion Power

The International Thermonuclear Experimental Reactor (ITER)—which aims to prove the commercial viability of fusion power—is slated to be built in France by 2016. Here's how it will work.

Two hydrogen isotopes—deuterium and tritium—are heated in a doughnut-shaped chamber to more than 100 million °C, at which point they form a plasma, or ionized gas. Superconducting coils surrounding the chamber wall create a magnetic field that confines the plasma, forcing the deuterium and tritium nuclei to collide; when they do, they fuse to form helium nuclei, releasing neutrons. The mass of a helium nucleus and a neutron is less than that of a deuterium nucleus and a tritium nucleus; the excess mass is converted into a tremendous amount of energy, which is imparted to the helium nuclei and the neutrons. When the fast-moving neutrons hit the "blanket" that lines the chamber, they generate heat within it, which can be harnessed to produce electricity. Since there's no plentiful natural source of tritium, ITER will test ways of using some of the neutrons to create tritium from lithium-bearing materials in the blanket.

SOURCE: INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR