

from his home kitchen table,” says Guha. Tromp’s colleague James Hanon is working on an iPhone app to monitor the same instrument.

“What doesn’t get enough credit is how the high demand for mobile devices has driven innovation in processors,” says Gaurav Khanna, a theoretical astrophysicist at the University of Massachusetts Dartmouth. Khanna is involved in an NSF project cosponsored by Apple and graphics-hardware manufacturer Nvidia to evaluate the performance of mobile-device processors for scientific computing applications. He says that although current wireless bandwidth isn’t sufficient for supercomputing operations “even if you link 1000 iPads together,” the hardware inside mobile devices is up to the job. They’ve been designed to have “extremely high performance without draining the battery too quickly,” he says.

### A global sensing system

Until recently, the most common use for personal mobile devices by scientists had been to access and share research results, says Enrique Canessa, a scientist at the Abdus Salam International Centre for Theoretical Physics in Trieste, Italy. Last November at ICTP, Canessa and colleague Marco Zennaro hosted an international workshop on mobile science

that featured sessions on designing apps for data collection and analysis. The workshop also introduced a moniker for mobile science research—m-science—and launched the primer *m-Science: Sensing, Computing and Dissemination*, which can be downloaded for free at <http://www.m-science.net>. Canessa says he expects the book to raise awareness of the “huge possibilities of mobile science” and to “motivate a new generation to participate in this rapidly developing new field of research.”

To that end, Canessa and Zennaro have designed a potentiality index to assess countries on their ability to participate in mobile science. The index, which takes into account an area’s density of broadband subscribers and density of working scientists, shows smaller, developed nations like the Netherlands to be most ready for m-science; it also suggests that developing nations, despite being the fastest adopters of mobile technology, will be limited by the relatively low density of scientists in their populations.

A global sensing system is the promise of m-science, says Zennaro. With minimal participation, “we could build the largest scientific instrument ever built; one that could aggregate data on an unprecedented scale.”

Jermev N. A. Matthews

## Old satellite dishes become new telescopes

**Recycling offers radio astronomers a cheap ticket to expand interferometers, train students, and boost science in developing countries.**

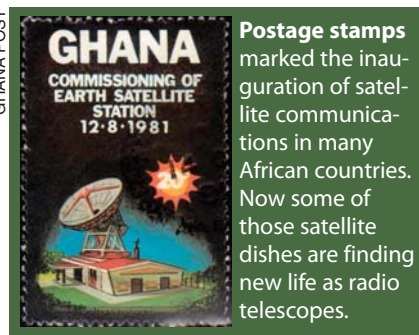
“It’s not a new concept, but now is the time,” says Justin Jonas, associate director for science and engineering with the Square Kilometre Array (SKA) South Africa Project. With optical fibers replacing satellite communications dishes, radio astronomers around the world are converting the obsolete dishes into telescopes. Many dishes across Africa, for example, have been identified as conversion candidates, and one in Ghana is set to go forward. The UK’s Goonhilly Earth Station, which in 1962 received the first transatlantic television broadcasts, is getting a makeover. Other recent or planned retrofits can be found in Australia, New Zealand, Japan, and elsewhere.

“Adding one telescope doesn’t make a scientific revolution, but if you could double the number [in the European Very Long Baseline Interferometry Network (EVN)], that would revolutionize

our field,” says Huib van Langevelde, director of the Joint Institute for VLBI in Europe, based in Dwingeloo, the Netherlands. “Our images would be much more accurate and look better, and we could sample a larger number of sources.”

Many recycled dishes are also used to train students and to promote science

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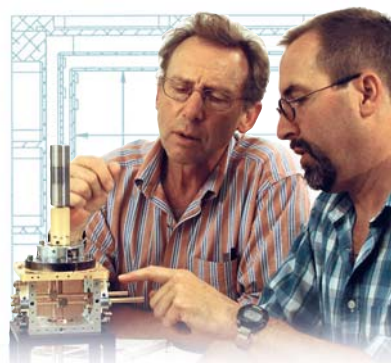


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in developing countries. In Peru, whose universities do not offer astronomy degrees, José Ishitsuka is overseeing the transformation of a 32-meter satellite communications dish into a single-frequency telescope that will be dedicated to observing methanol masers from emerging stars. Once the telescope is running, says Ishitsuka, “it will allow young people to do research and write papers on the world level.”

## The Africa gap

A few years ago, failed bearings temporarily shut down the Hartebeesthoek radio telescope near Johannesburg, South Africa. With time on his hands, observatory director Mike Gaylard discovered some two dozen 30-meter satellite dishes in as many countries in Africa. “I tracked down a whole lot with stamps and Google Earth,” he says, noting that many countries issued postage stamps to mark a satellite dish’s inauguration. Although some dishes have been scrapped, he says, “there are dishes in Kenya, Ethiopia, Zimbabwe. . . . It’s quite tantalizing for a radio astronomer to consider linking antennas to the VLBI networks.”

“Africa is really quite interesting for radio astronomy,” says van Langevelde. The EVN does not “have the sensitivity

for things extended in the north–south direction because we only have that one telescope [Hartebeesthoek] in South Africa. The whole African continent is a blank spot in our vision.”

“We want to identify antennas in Africa to fill the gap,” says Jonas, “and at the same time put some flesh onto collaborations.” Such collaborations began as part of South Africa’s bid to host the SKA—the world’s largest radio astronomy array, for which a site decision between that country and Australia is expected next year. “We are going to establish the Africa array whether or not the SKA occurs here. And it’s something we can do in the next few years, for a fairly small investment.”

Retrofitting a satellite dish involves installing new receivers, fixing or replacing steering mechanisms and electronics, and adding telescope control software, maser clocks for interferometric measurements, and sometimes fiber-optic connections. The cost of refurbishing a dish ranges from \$100 000, like the project in Peru, to a couple million dollars, about one-tenth the cost of building a new 30-meter radio astronomy telescope.

Ghana, for one, jumped at the opportunity to retrofit when it was proposed by astronomers from South Africa. A de-

fect satellite dish about 30 km north-east of Accra, the capital city, will become the flagship of a planned space science and technology center, says Adelaide Asante, a research officer in Ghana’s science and technology ministry. With no radio astronomers in the country, Asante notes that the new center will stress both training and research. “In a developing country, you have to balance research with what the facility can do for the country.”

## A commercial approach

The Goonhilly conversion combines radio astronomy with two potentially moneymaking ventures: a spacecraft tracking business and a visitors’ center. Last January partners in academia and industry kicked off the effort to save the site. Ian Jones, who worked in telephone and aircraft communications at Goonhilly in its heyday, is leading the charge.

One of the site’s three 30-meter-class dishes will be for radio astronomy, one will be dedicated to tracking spacecraft, and the third will be equipped for both uses. Some of the site’s 15-meter dishes will also be fixed up for use in a local interferometer and for training students.

Although the Goonhilly dishes could be used on their own, the prospect of linking to the UK’s e-MERLIN inter-

## New radio telescope eyes sky from Sardinia

Scientists are set to begin debugging the 64-meter Sardinia Radio Telescope (SRT) in southern Italy and plan to make the first observations later this year.

The 500-ton dish was raised in one piece and placed on its 34-meter-tall platform last year (see videos at <http://www.srt.inaf.it/multim/videos>). “It was an incredible operation,” says project director Nicolò D’Amico. “Usually, dishes are raised in pieces and then aligned and welded up top.”

The SRT will be used in conjunction with interferometers such as the EVN—the European Very Long Baseline Interferometry (VLBI) Network. After the 100-meter dish in Effenberg, Germany, the SRT will be the second-largest dish in the network, which links 8 to 13 radio telescopes, depending on frequency. The SRT’s initial sensitivity range is 0.3–22 GHz, with a planned stepwise increase to around 100 GHz. The dish’s 1008 electro-mechanical actuators, which compensate for gravitational deformations, are especially important at higher frequencies. Says Huib van Langevelde, director of the Joint Institute for VLBI in Europe, “Such a large telescope that goes to 3 millimeters [100 GHz] is a major addition to the EVN.” For example, he says, in Europe “we don’t have the sensitivity to probe molecular transitions that produce short-wavelength maser emissions. That will be possible with the SRT.” The telescope will also work with other interferometers, including the US’s Very Long Baseline Array. On its own, the SRT will be used to study pulsars, masers, and other radio sources; identify targets for the interferometers; and track spacecraft missions.

The €60 million (\$87 million) tab for the SRT was paid by local and national governments and by the Italian Space Agency (ASI), which has a 20% share in the telescope. The Italian economy has



**The Sardinia Radio Telescope** will start collecting data later this year.

INAF—OSSERVATORIO ASTRONOMICCO DI CAGLIARI

taken a nosedive since construction began in 2003, and D’Amico is concerned about coming up with €3 million for annual operations. Despite radio astronomers having to deal with interference from transmissions in the ASI satellite-tracking applications, D’Amico says that with money tight, “we are happy that ASI is involved.” Given the austere policies introduced into Italy’s public sector (see PHYSICS TODAY, December 2008, page 31), hiring the two dozen or so people needed to operate the telescope is on hold.

**Toni Feder**



**The Goonhilly Earth Station** in Cornwall, UK, is being converted to a multiuse site for spacecraft tracking and radio astronomy.

ferometer is what really has radio astronomers excited. With Goonhilly, e-MERLIN's baseline would grow from about 217 km to 400 km, doubling the interferometer's resolution. Because of its location, Goonhilly would also improve the resolution looking south.

An extended e-MERLIN could study star and galaxy formation, black holes, protoplanetary disks, and, with gravitational lensing, dark matter located between Earth and distant radio sources. The interferometer would have similar resolution to the Atacama Large Millimeter Array (ALMA) in Chile, says the University of Leeds's Melvin Hoare, who heads

the Consortium of Universities for Goonhilly Astronomy. "ALMA can look at cold molecular gases, e-MERLIN is good at looking at ionized gas, so you can get links between molecular and ionized gases." Such "frontline science" opened up by linking to e-MERLIN "is the real beauty of the [Goonhilly] telescopes," he says.

The four consortium members signed on to the project in May and have put in cash and in-kind contributions toward their aim of £500 000 (\$800 000). That will cover the cost of outfitting at least one 30-meter telescope. They are still seeking roughly £1 million to link Goonhilly to e-MERLIN. **Toni Feder**

## Obama's R&D plan seeks a renaissance in US manufacturing

**Robotics, new materials, and improved energy efficiency are among the elements of a multiagency effort. But lawmakers bent on cutting spending will have to okay the new funding.**

**President Obama's program** to assist US industries in developing advanced manufacturing technologies would devote as much as \$500 million annually to R&D projects at NIST, the Department of Energy, the National Institutes of Health, and the Defense Advanced Research Projects Agency (DARPA).

In announcing the Advanced Manufacturing Partnership during a speech at Carnegie Mellon University (CMU) on 24 June, Obama closely adhered to the recommendations of the President's Council of Advisors on Science and Technology (PCAST), which called for a cooperative R&D program among government, industry, and academia to address the most pressing technological challenges that are common to US manufacturers. Elements of the partnership program include a \$100 million Materials Genome Initiative aimed at cutting in half the time and cost required to identify and mass produce new materials for

specific applications, a \$70 million National Robotics Initiative to develop robots capable of working safely alongside humans, and up to \$120 million over several years for the development of more energy-efficient manufacturing processes and materials.

"We've launched an all-hands-on-deck effort between our brightest academic minds, some of our boldest business leaders, and our most dedicated public servants from science and technology agencies, all with one big goal, and that is a renaissance of American manufacturing," Obama said. Initial participants include 6 universities and 12 manufacturers from various industries. Ron Bloom, assistant to the president for manufacturing policy, stressed that the collaboration remains open to other institutions and companies.

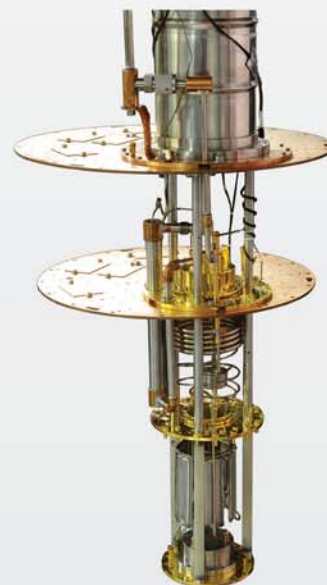
Advanced materials manufacturing processes will enable the development of new materials to improve the performance of electric-vehicle batteries,

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