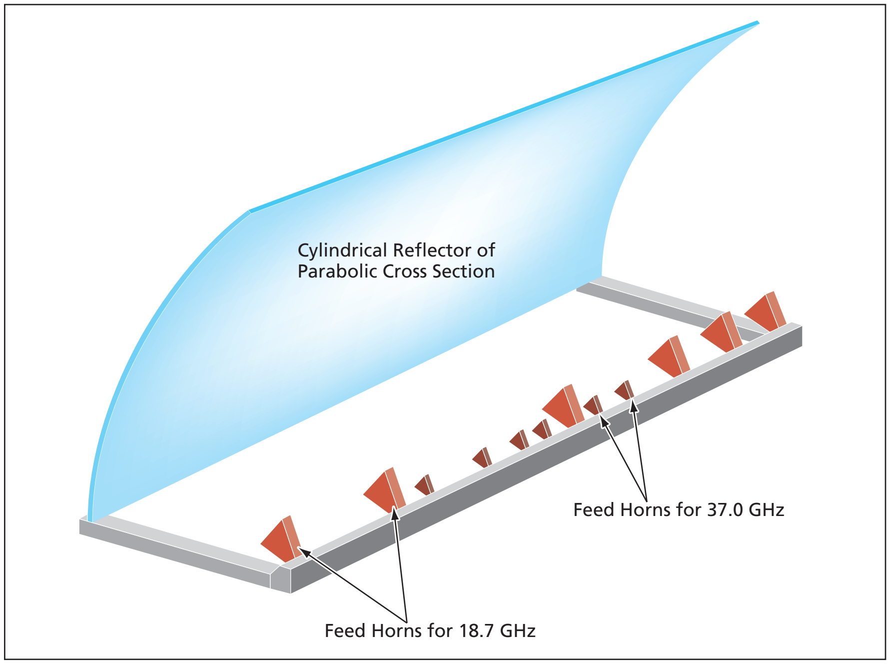
A One-Dimensional Synthetic-Aperture Microwave Radiometer

Phased microwave feed horns would be arrayed sparsely along a cylindrical parabolic reflector.

Goddard Space Flight Center, Greenbelt, Maryland

A proposed one-dimensional synthetic-aperture microwave radiometer could serve as an alternative to either the two-dimensional synthetic-aperture radiometer described in the immediately preceding article or to a prior one-dimensional one, denoted the Electrically Scanned Thinned Array Radiometer (ESTAR), mentioned in that article. The proposed radiometer would operate in a "push-broom" imaging mode, utilizing (1) interferometric cross-track scanning to obtain cross-track resolution and (2) the focusing property of a reflector for along-track resolution.

The most novel aspect of the proposed system would be the antenna (see figure), which would include a cylindrical reflector of offset parabolic cross section. The reflector could be made of a lightweight, flexible material amenable to stowage and deployment. Other than a stowage/deployment mechanism, the antenna would not include moving parts, and cross-track scanning would not entail mechanical rotation of the antenna. During operation, the focal line, parallel to the cylindrical axis, would be oriented in the cross-track direction, so that placement of receiving/radiating elements at the focal line would afford the desired along-track resolution.



The **Antenna of the Proposed Radiometer** would consist of microwave feed horns positioned along the focal line of a cylindrical parabolic reflector. In one potential application, there would be two sets of feed horns for operation at two frequencies: the larger ones would be 18.7 GHz, the smaller ones for 37.0 GHz.

The elements would be microwave feed horns sparsely arrayed along the focal line. The feed horns would be oriented with their short and long cross-sectional dimensions parallel and perpendicular, respectively, to the cylindrical axis to obtain fan-shaped beams having their broad and narrow cross-sectional dimensions parallel and perpendicular, respectively, to the cylindrical axis. The interference among the beams would be controlled in the same manner as in the ESTAR to obtain along-cylindrical-axis (cross-track) resolution and cross-track scanning.

This work was done by Terence Doiron and Jeffrey Piepmeier of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14748-1

Electrical Switching of Perovskite Thin-Film Resistors

Physical properties are altered in useful ways by applying electrical pulses.

Marshall Space Flight Center, Alabama

Electronic devices that exploit electrical switching of physical properties of thin films of perovskite materials (especially colossal magnetoresistive materials) have been invented. Unlike some related prior devices, these devices function at room temperature and do not depend on externally applied magnetic fields. Devices of this type can be designed to function as sensors (exhibiting varying electrical resistance in response to varying temperature, magnetic field, electric field, and/or mechanical pressure) and as elements of electronic memories.

The underlying principle is that the application of one or more short electrical pulse(s) can induce a reversible, irreversible, or partly reversible change in the electrical, thermal, mechanical, and magnetic properties of a thin perovskite film. The energy in the pulse must be large enough to induce the desired change but not so large as to destroy the film. Depending on the requirements of a specific application, the pulse(s) can have any of a large variety of waveforms (e.g., square, triangular, or sine) and be of positive, negative, or alternating polarity. In some applications, it could be necessary to use multiple pulses to induce successive incremental physical changes.

In one class of applications, electrical pulses of suitable shapes, sizes, and polarities are applied to vary the detection sensitivities of sensors. Another class of applications arises in electronic circuits in which certain resistance values are required to be variable: Incorporating the affected resistors into devices of the present type makes it possible to control their resistances electrically over wide ranges, and the lifetimes of electrically variable resistors exceed those of conventional mechanically variable resistors. Another and potentially the most important class of applications is that of resistance-based nonvolatile-memory devices, such as a resistance random access memory (RRAM) described in the immediately following article, "Electrically Variable Resistive Memory Devices" (MFS-32511-1).

This work was done by Shangqing Liu, Nai-Juan Wu, and Alex Ignatiev of the University of Houston for Marshall Space Flight Center. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32512-1.

Two-Dimensional Synthetic-Aperture Radiometer

Aperture synthesis is employed to reduce antenna mass.

Goddard Space Flight Center, Greenbelt, Maryland

A two-dimensional synthetic-aperture radiometer, now undergoing development, serves as a test bed for demonstrating the potential of aperture synthesis for remote sensing of the Earth, particularly for measuring spatial distributions of soil moisture and ocean-surface salinity. The goal is to use the technology for remote sensing aboard a spacecraft in orbit, but the basic principles of design and operation are applicable to remote sensing from aboard an aircraft, and the prototype of the system under development is designed for operation aboard an aircraft.

In aperture synthesis, one utilizes several small antennas in combination with a signal processing in order to obtain resolution that otherwise would require the use of an antenna with a larger aperture (and, hence, potentially more difficult to deploy in space). The principle upon which this system is based is similar to that of Earth-rotation aperture synthesis employed in radio astronomy. In this technology the coherent products (correlations) of signals from pairs of antennas are obtained at different antenna-pair spacings (baselines). The correlation for each baseline yields a sample point in a Fourier transform of the brightness-temperature map of the scene. An image of the scene itself is then reconstructed by inverting the sampled transform.

The predecessor of the present two-dimensional synthetic-aperture radiometer is a one-dimensional one, named the Electrically Scanned Thinned Array Radiometer (ESTAR). Operating in the L band, the ESTAR employs aperture synthesis in the cross-track dimension only, while using a conventional antenna for resolution in the along-track dimension.

The two-dimensional instrument also operates in the L band — to be precise, at a frequency of 1.413 GHz in the frequency band restricted for passive use (no transmission) only. The L band was chosen because (1) the L band represents the long-wavelength end of the remote-sensing spectrum, where the problem of achieving adequate spatial resolution is most critical and (2) imaging airborne instruments that operate in this wavelength range and have adequate spatial resolution are difficult to build and will be needed in future experiments to validate approaches for remote sensing of soil moisture and ocean salinity.

The two-dimensional instrument includes a rectangular array of patch antennas arranged in the form of a cross. The ESTAR uses analog correlation for one dimension, whereas the two-dimensional instrument uses digital correlation. In two dimensions, many more correlation pairs are needed and low-power digital correlators suitable for application in spaceborne remote sensing will help enable this technology. The two-dimensional instrument is dual-polarized and, with modification, capable of operating in a polarimetric mode. A flight test of the instrument took place in June 2003 and it participated in soil moisture experiments during the summers of 2003 and 2004.

This work was done by David M. Le Vine of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14809-1

Ethernet-Enabled Power and Communication Module for Embedded Processors

This device enables serial-to-Ethernet conversion and provides power to remote locations without adding cables.

John F. Kennedy Space Center, Florida

The power and communications module is a printed circuit board (PCB) that has the capability of providing power to an embedded processor and converting Ethernet packets into serial data to transfer to the processor. The purpose of the new design is to address the shortcomings of previous designs, including limited bandwidth and program memory, lack of control over packet processing, and lack of support for timing synchronization.

The module includes an RJ-45 with integrated magnetics and power passthrough, integrated Power over Ethernet (PoE) controller, an Ethernet controller [media access controller (MAC)], a Silicon Laboratories C8051F120 microcontroller with synchronous and asynchronous communication ports, a real-time clock, a hardware watchdog timer, a DC-DC converter with triple output, and 1 Mbit of non-volatile ferroelectric RAM. This new kind of RAM, called FRAM,