Portable Airborne Laser System Measures Forest-Canopy Height

This system can be built, operated, and repaired at relatively low cost.

Goddard Space Flight Center, Greenbelt, Maryland

The Portable Airborne Laser System (PALS) is a combination of laser ranging, video imaging, positioning, and data-processing subsystems designed for measuring the heights of forest canopies along linear transects from tens to thousands of kilometers long. Unlike prior laser ranging systems designed to serve the same purpose, the PALS is not restricted to use aboard a single aircraft of a specific type: the PALS fits into two large suitcases that can be carried to any convenient location, and the PALS can be installed in almost any local aircraft for hire, thereby making it possible to sample remote forests at relatively low cost. The initial cost and the cost of repairing the PALS are also lower because the PALS hardware consists mostly of commercial off-the-shelf (COTS) units that can easily be replaced in the field.

The COTS units include a laser ranging transceiver, a charge-coupled-device camera that images the laser-illuminated targets, a differential Global Positioning System (dGPS) receiver capable of operation within the Wide Area Augmentation System, a video titler, a video cassette recorder (VCR), and a laptop computer equipped with two serial ports. The VCR and computer are powered by batteries; the other units are powered at 12 VDC from the 28-VDC aircraft power system via a low-pass filter and a voltage converter.

The dGPS receiver feeds location and time data, at an update rate of 0.5 Hz, to the video titler and the computer. The laser ranging transceiver, operating at a sampling rate of 2 kHz, feeds its serial range and amplitude data stream to the computer. The analog video signal from the CCD camera is fed into the video titler wherein the signal is annotated with position and time information. The titler then forwards the annotated signal to the VCR for recording on 8-mm tapes. The dGPS and laser range and amplitude serial data streams are processed by software that displays the laser trace and the dGPS information as they are fed into the computer, subsamples the laser range and amplitude data, interleaves the subsampled data with the dGPS information, and records the resulting interleaved data stream.

This work was done by Ross Nelson of **Goddard Space Flight Center**. *Further information is contained in a TSP (see page 1).*
GSC-14906-1

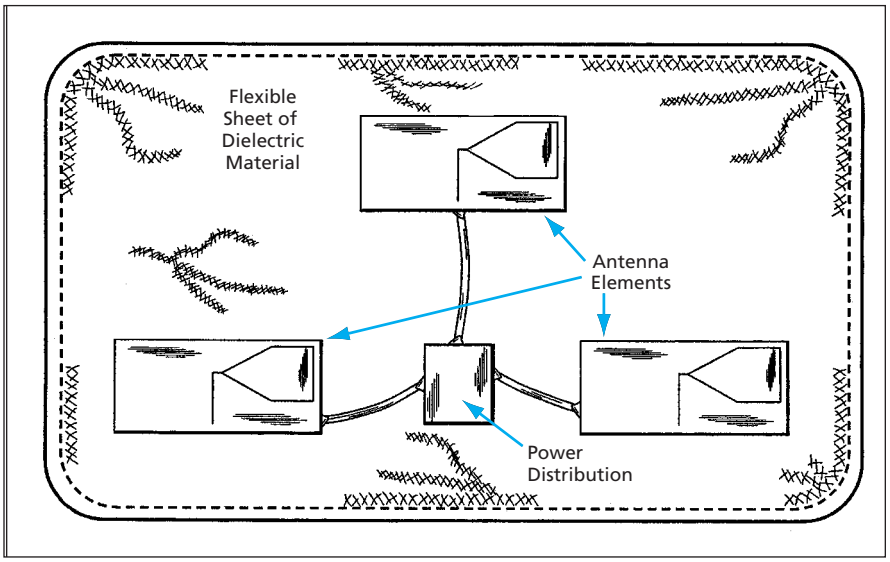
Deployable Wide-Aperture Array Antennas

Antennas would be unrolled or unfolded to full size when and where needed.

Lyndon B. Johnson Space Center, Houston, Texas

Inexpensive, lightweight array antennas on flexible substrates are under development to satisfy a need for large-aperture antennas that can be stored compactly during transport and deployed to full size in the field. Conceived for use aboard spacecraft, antennas of this type also have potential terrestrial uses — most likely, as means to extend the ranges of cellular telephones in rural settings.

Several simple deployment mechanisms are envisioned. One example is shown in the figure, where the deployment mechanism, a springlike material contained in a sleeve around the perimeter of a flexible membrane, is based on a common automobile window shade. The array can be formed of antenna elements that are printed on small sections of semi-flexible laminates, or preferably, elements that are constructed of conducting fabric. Likewise,



A **Wide Array of Four Radiating Antenna Elements** and their transmission line would be made from flexible conductive materials on a flexible dielectric sheet. When not in use, the antenna could be rolled into a compact cylinder in the manner of a window shade.

a distribution network connecting the elements can be created from conventional technologies such as lightweight, flexible coaxial cable and a surface mount power divider, or preferably, from elements formed from conductive fabrics. Conventional technologies may be stitched onto a supporting flexible membrane or contained within pockets that are stitched onto a flexible membrane. Components created from conductive fabrics may be attached by stitching conductive strips to a nonconductive membrane, embroidering conductive threads into a nonconductive membrane, or weaving predetermined patterns directly into the membrane.

The deployable antenna may comprise multiple types of antenna elements. For example, thin profile antenna elements above a ground plane, both attached to the supporting flexible membrane, can be used to create a unidirectional boresight radiation pattern. Or, antenna elements without a ground plane, such as bow-tie dipoles, can be attached to the membrane to create a bidirectional array such as that shown in the figure. For either type of antenna element, the dual configuration, i.e., elements formed of slots in a conductive membrane, can also be used. Finally, wide bandwidth antennas or arrays can be formed in which the principal direction of radiation is in the plane of the membrane. For this embodiment, the set of elements on the membrane is arranged to form one or more traveling wave antennas. In this case, a nonconductive form of the perimeter springlike material is required to provide the deploying force.

This work was done by Patrick W. Fink, Justin A. Dobbins, Greg Y. Lin, Andrew Chu, and Robert C. Scully of **Johnson Space Center**. *This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23436.*

Faster Evolution of More Multifunctional Logic Circuits

Evolution is driven to find circuits that perform larger numbers of logic functions.

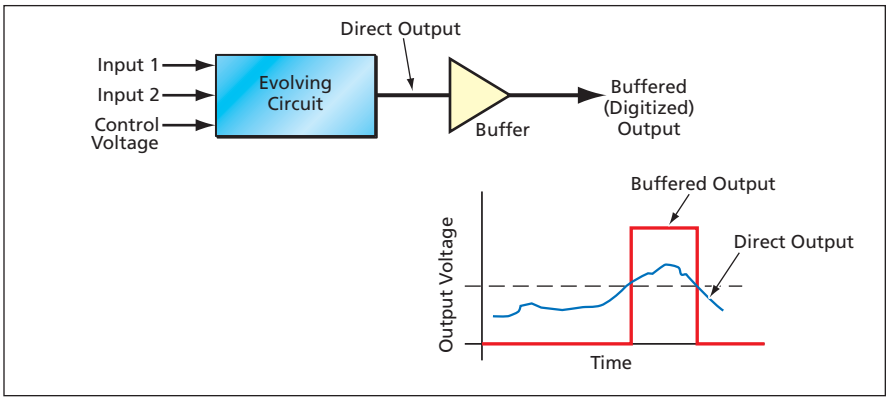
NASA's Jet Propulsion Laboratory, Pasadena, California

A modification in a method of automated evolutionary synthesis of voltage-controlled multifunctional logic circuits makes it possible to synthesize more circuits in less time. Prior to the modification, the computations for synthesizing a four-function logic circuit by this method took about 10 hours. Using the method as modified, it is possible to synthesize a six-function circuit in less than half an hour.

The concepts of automated evolutionary synthesis and voltage-controlled multifunctional logic circuits were described in a number of prior *NASA Tech Briefs* articles. To recapitulate: A circuit is designed to perform one of several different logic functions, depending on the value of an applied control voltage. The circuit design is synthesized following an automated evolutionary approach that is so named because it is modeled partly after the repetitive trial-and-error process of biological evolution. In this process, random populations of integer strings that encode electronic circuits play a role analogous to that of chromosomes. An evolved circuit is tested by computational simulation (prior to testing in real hardware to verify a final design). Then, in a fitness-evaluation step, responses of the circuit are compared with specifications of target responses and circuits are ranked according to how close they come to satisfying specifications. The results of the evaluation provide guidance for refining designs through further iteration.

As described in more detail in the prior *NASA Tech Briefs* articles on multifunctional logic circuits, the multiple functionality of these circuits, the use of a single control voltage to select the function, and the automated evolutionary approach to synthesis, offer potential advantages for the further development of field-programmable gate arrays (FPGAs):

- Typical circuitry can be less complex and can occupy smaller areas; because only a single analog control line is needed to select different functions.
- If voltage-controlled multifunctional gates were used in the place of the configurable logic blocks of present commercial FPGAs, it would be possible to change the functions of the resulting digital systems in much shorter times;
- Relative to conventional circuits designed to perform single functions, multifunctional circuits can be synthesized to be more tolerant of radiation-induced faults.



A **Buffer Must Be Added** to an evolving circuit to obtain a digital output because the direct output of a typical evolving circuit is an analog voltage.

In the unmodified method of automated evolutionary synthesis, the target responses of a multifunctional logic circuit are fixed: that is, the user specifies in advance which logic function the circuit is to perform at each of several discrete values of control voltage (for example, AND at 0 V, NOR at 0.9 V, and NAND at 1.8 V). In the modified method, the user no longer specifies which logic function occurs at which control voltage: Instead, the evolutionary algorithm is allowed to find the control-voltage levels at which various logic functions appear, and the fitness-evaluation function is modified to assign a higher fitness score to a circuit that exhibits a greater number of logic functions over the full range of the control voltage. Thus, evolution is driven to