Receiver Would Control Phasing of a Phased-Array Antenna

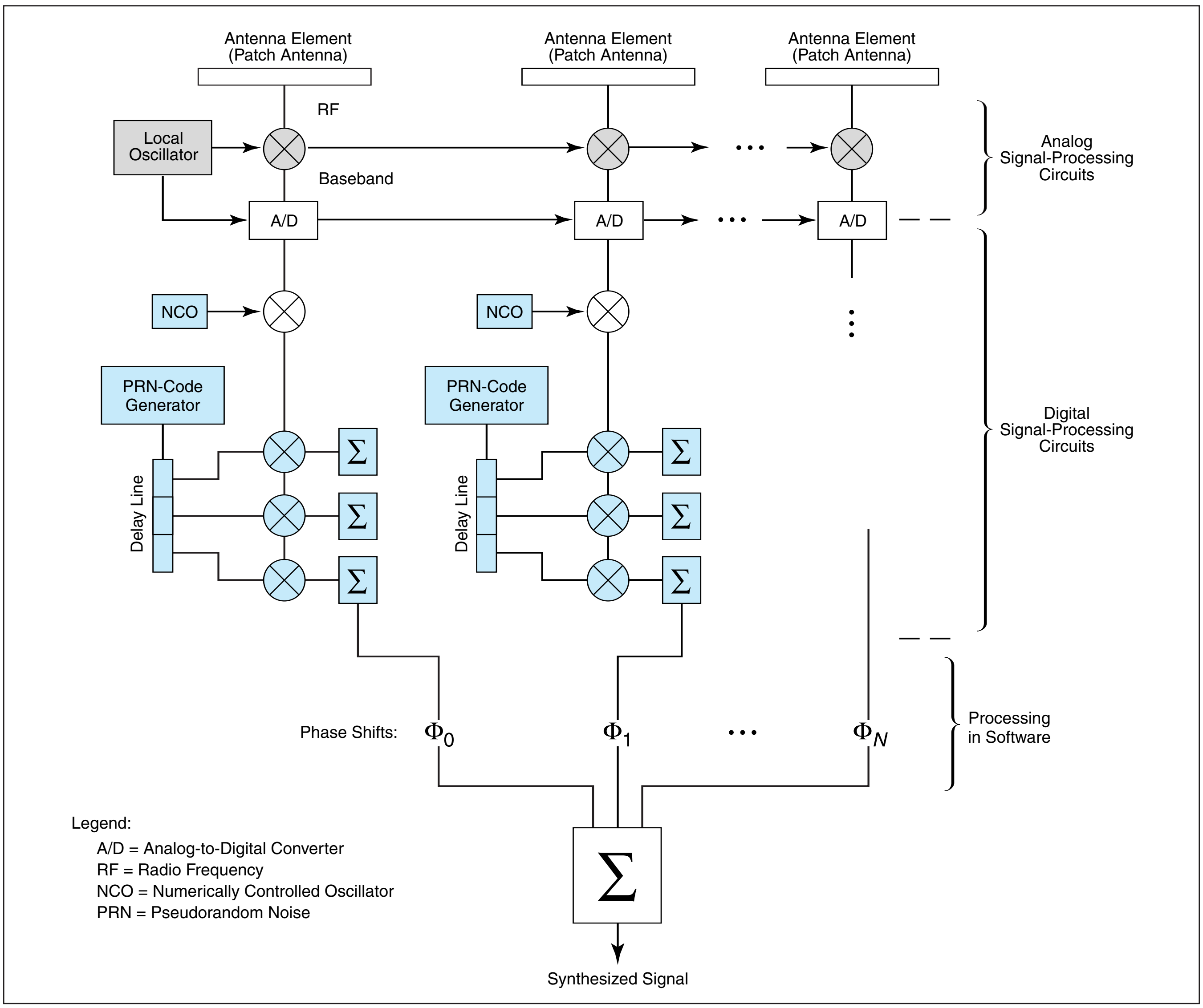
Peaks and nulls would be aimed to optimize reception.

NASA's Jet Propulsion Laboratory, Pasadena, California

In a proposed digital signal-processing technique, a radio receiver would control the phasing of a phased-array antenna to aim the peaks of the antenna radiation pattern toward desired signal sources while aiming the nulls of the pattern toward interfering signal sources. The technique was conceived for use in a Global Positioning System (GPS) receiver, for which the desired signal sources would be GPS satellites and typical interference sources would be terrestrial objects that cause multipath propagation. The technique could also be used to optimize reception in spread-spectrum cellular-telephone and military communication systems.

During reception of radio signals in a conventional phased-array antenna system, received signals at their original carrier frequencies are phase-shifted, then combined by analog circuitry. The combination signal is then subjected to downconversion and demodulation.

In a system according to the proposed technique (see figure), the signal received by each antenna would be subjected to downconversion, spread-spectrum demodulation, and correlation; this processing would be performed separately from, and simultaneously with, similar processing of signals received by the other antenna elements. Following ana-



Baseband Signals Would Be Digitized and processed in parallel. Phase shifts could be added in software to aim the peaks and nulls of the antenna radiation pattern; the effect would be equivalent to that of beam steering by phase shifting in hardware.

log downconversion to baseband, the signals would be digitized, and all subsequent processing would be digital.

In the digital process, residual carriers would be removed and each signal would be correlated with a locally generated model pseudorandum-noise code, all following normal GPS procedure. As part of this procedure, accumulated values would be added in software and the resulting signals would be phase-shifted in software by the amounts necessary to synthesize the desired antenna directional gain pattern of peaks and nulls.

The principal advantage of this technique over the conventional radio-frequency-combining technique is that the parallel digital baseband processing of the signals from the various antenna elements would be a relatively inexpensive and flexible means for exploiting the inherent multiple-peak/multiple-null aiming capability of a phased-array antenna. In the original intended GPS application, the peaks and nulls could be directed independently for each GPS signal being tracked by the GPS receiver. The technique could also be applied to other code-division multiple-access communication systems.

This work was done by Charles E. Dunn and Lawrence E. Young of Caltech for **NASA's Jet Propulsion Laboratory***. Further information is contained in a TSP (see page 1).*

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, NASA Management Office–JPL, (818) 354-7770. Refer to NPO-20031.

Modern Design of Resonant Edge-Slot Array Antennas

Better antennas can be designed at lower cost.

Goddard Flight Space Center, Greenbelt, Maryland

Resonant edge-slot (slotted-waveguide) array antennas can now be designed very accurately following a modern computational approach like that followed for some other microwave components. This modern approach makes it possible to design superior antennas at lower cost than was previously possible.

Heretofore, the physical and engineering knowledge of resonant edge-slot array antennas had remained immature since they were introduced during World War II. This is because despite their mechanical simplicity, high reliability, and potential for operation with high efficiency, the electromagnetic behavior of resonant edge-slot antennas is very complex. Because engineering design formulas and curves for such antennas are not available in the open literature, designers have been forced to implement iterative processes of fabricating and testing multiple prototypes to derive design databases, each unique for a specific combination of operating frequency and set of waveguide tube dimensions. The expensive, time-consuming nature of these processes has inhibited the use of resonant edge-slot antennas. The present modern approach reduces costs by making it unnecessary to build and test multiple prototypes. As an additional benefit, this approach affords a capability to design an array of slots having different dimensions to taper the antenna illumination to reduce the amplitudes of unwanted side lobes.

The heart of the modern approach is the use of the latest commercially available microwave-design software, which implements finite-element models of electromagnetic fields in and around waveguides, antenna elements, and similar components. Instead of building and testing prototypes, one builds a database and constructs design curves from the results of computational simulations for sets of design parameters.

The figure shows a resonant edge-

This **Resonant Edge-Slot Antenna** with tapered illumination was designed on the basis of computational simulations, instead of following the traditional approach of iterative fabrication and testing of prototypes.