Each VTU contains a free-running, extremely stable clock, based on a 32,768-Hz (2^{15}-Hz) quartz-crystal oscillator. The clock begins a binary count up from zero when reset and continues counting up until reset again (or until it automatically restarts from zero when the time code repeats after more than 136 years). Each VTU also contains digital and analog audio circuitry required for synchronization of video recording.

The GeoTimeCode is a variant of the Inter Range Instrumentation Group B (IRIG-B) time code, which is widely used in the aerospace industry. The GeoTimeCode can easily be converted to other standard time codes, including the Society of Motion Picture and Television Engineers (SMPTE) time code. The GeoTimeCode is similar enough to the IRIG-B time code that software can easily be adapted to read either code.

A VTU can be synchronized to a Universal Time source (e.g., an Internet time server or a radio time signal) or to other, possibly distant VTUs by use of a computer equipped with the appropriate software and ancillary electronic hardware. Optionally, without using a computer, multiple VTUs can be synchronized with each other by temporarily connecting them together via standard patch cables and pressing a reset button. At the instant when synchronization is performed, the synchronization is accurate to within less than a millisecond. Synchronization can be done either before or after a video recording is made; the clock in a VTU is stable and accurate enough that as long as synchronization is performed within about 8 hours of recording, timing is accurate to within 0.033 second (a typical video frame period).

A portion of the time code is reserved for a serial number that identifies each VTU and, hence, the camera from which each recording is taken. Another portion of the time code is reserved for event markers, which can be added manually during recording by means of a pushbutton switch. Each event marker includes an event number from a counter that is incremented for each event. The serial numbers and event markers can be used to identify specific image sequences during post processing of video images by editing software.

This work was done by William "Bud" Nail, William L. Nail, Jasper M. Nail, and Duong T. Le of Technological Services Co. for Stennis Space Center.

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Refer to SSC-00253, volume and number of this NASA Tech Briefs *issue, and the page number*

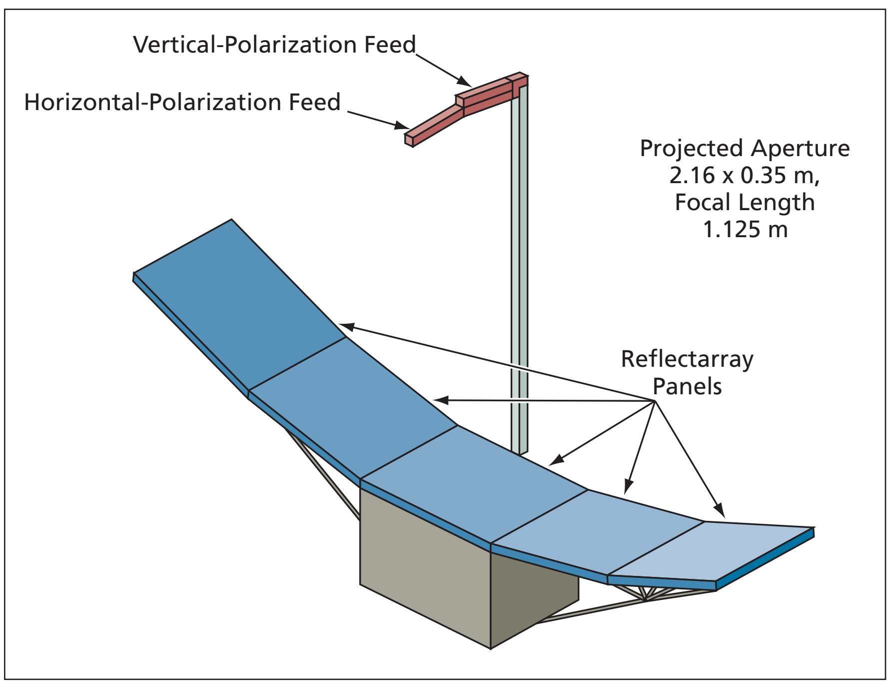
Piecewise-Planar Parabolic Reflectarray Antenna

Performance is equalized in horizontal and vertical polarizations.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure shows a dual-beam, dual-polarization Ku-band antenna, the reflector of which comprises an assembly of small reflectarrays arranged in a piecewise-planar approximation of a parabolic reflector surface. The specific antenna design is intended to satisfy requirements for a wide-swath spaceborne radar altimeter, but the general principle of piecewise-planar reflectarray approximation of a parabolic reflector also offers advantages for other applications in which there are requirements for wide-swath antennas that can be stowed compactly and that perform equally in both horizontal and vertical polarizations.

The main advantages of using flat (e.g., reflectarray) antenna surfaces instead of paraboloidal or parabolic surfaces is that the flat ones can be fabricated at lower cost and can be stowed and deployed more easily. Heretofore, reflectarray antennas have typically been designed to reside on single planar surfaces and to emulate the focusing properties of, variously, paraboloidal (dish) or parabolic antennas. In the present case, one approximates the nominal parabolic shape by concatenating several flat pieces, while still exploiting the principles of the planar reflectarray for each piece.



Five Flat Panels are arranged in a piecewise-planar approximation of a parabolic reflector surface. Each panel is a reflectarray designed to emulate the corresponding part of the parabolic reflector.

Prior to the conception of the present design, the use of a single large reflectarray was considered, but then abandoned when it was found that the directional and gain properties of the antenna would be noticeably different for the horizontal and vertical polarizations. The reason for this difference in performance is related to strong spatial variations in phase, including phase wraps (phase variations in excess of 360°).

By arranging small reflectarrays in a piecewise-planar approximation of a parabola, instead of constructing one large reflectarray on a single planar surface, one minimizes the number of phase wraps per panel and reduces the angle of incidence at each reflectarray patch. This makes it possible to simultaneously maximize the vertical- and horizontal-polarization gains, to improve the radiation pattern, and reduce sensitivity to fabrication and adjustment errors.a

This work was done by Richard Hodges and Mark Zawadzki of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.
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Reducing Interference in ATC Voice Communication

Digital signal processing would be used to suppress unwanted signals.

NASA's Jet Propulsion Laboratory, Pasadena, California

Three methods have been proposed to be developed to enable reduction of the types of interference that often occur among voice-communication radio signals involved in air-traffic control (ATC). For historical reasons and for compatibility with some navigation systems, control towers and aircraft use amplitude modulation (AM) for voice communication. In the presence of two simultaneous AM transmissions in the same frequency channel, what is heard through a receiver includes not only the audio portions of both transmissions but also an audio heterodyne signal at the difference between the carrier frequencies of the transmissions (as a practical matter, the carrier frequencies almost always differ somewhat). The situation is further complicated by multiple heterodyne signals in the presence of more than two simultaneous transmissions. Even if one of the transmissions does not include AM because of a transmitter malfunction or because a transmitter was inadvertently turned on or left on, the heterodyne signal makes it difficult to understand the audio of the other transmission. The proposed methods would utilize digital signal processing to counteract this type of interference.

In the first of the three methods, a post-detection audio digital signal processor (DSP) in a receiver would reduce the level of the heterodyne signal significantly. The DSP would be a self-contained unit that would be connected between (1) the output terminal of the ATC receiver audio circuitry and (2) a loudspeaker and/or headphones. The DSP would use a well-understood least-mean-square (LMS) algorithm to automatically adjust the coefficients of a finite-impulse-response filter in order to minimize the amplitude of such highly correlated signals as sine waves (including audio heterodyne signals). The DSP would operate without intervention by the human operator.

In the event that the first method as described thus far did not reduce interference sufficiently, it could be supplanted or augmented by a variant in which a DSP would be added to the last intermediate-frequency (IF) stage of the receiver, where it would be possible to effect improvements through increased dynamic range and linearity and the opportunity to shape the IF pass band for optimum rejection of other types of interference.

The second method, involving independent sideband reception, could be used alone or in combination with the first method. This method would exploit the fact that (1) the two simultaneously transmitted signals would not have the same carrier frequency and (2) the upper sideband would yield a higher signal-to-noise ratio (SNR) for the higher-carrier-frequency signal while the lower sideband would yield a higher SNR for the lower-carrier-frequency signal. Some development would be necessary to determine the best way to make use of the two signals.

In the third method, multiple antennas would be used for reception and their outputs would be combined by an adaptive beam former that would use the same LMS algorithm as that of the first method. In this case, the weighting between the antennas would be adjusted to minimize the coherent component of the received signal. A method equivalent to this one has been used in microwave data communication.

This work was done by John O. Battle of Caltech for NASA's Jet Propulsion Laboratory.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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