System Synchronizes Recordings From Separated Video Cameras
A large, immobile timing infrastructure is not needed.

Stennis Space Center, Mississippi

A system of electronic hardware and software for synchronizing recordings from multiple, physically separated video cameras is being developed, primarily for use in multiple-look-angle video production. The system, the time code used in the system, and the underlying method of synchronization upon which the design of the system is based are denoted generally by the term “GeoTimeCode™.” The system is embodied mostly in compact, lightweight, portable units (see figure) denoted video time-code units (VTUs) — one VTU for each video camera. The system is scalable in that any number of camera recordings can be synchronized. The estimated retail price per unit would be about $350 (in 2006 dollars).

The need for this or another synchronization system external to video cameras arises because most video cameras do not include internal means for maintaining synchronization with other video cameras. Unlike prior video-camera-synchronization systems, this system does not depend on continuous cable or radio links between cameras (however, it does depend on occasional cable links lasting a few seconds). Also, whereas the time codes used in prior video-camera-synchronization systems typically repeat after 24 hours, the time code used in this system does not repeat for slightly more than 136 years; hence, this system is much better suited for long-term deployment of multiple cameras.
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.

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 per-

### 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.

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**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.