When there are no more beams to transmit on the list, the build-down phase begins. In this phase, receive events begin when their respective timers pay off. When the timers have all paid off, the sweep is over and the instrument can begin a new sweep with a new list of beams.

Pulse collisions are avoided by the spacing of pulses during the build-up phase and by the order of the beams. As long as the range (delay) never decreases there will always be enough time between any 2 transmit pulses for the receive window and it can occur at its optimal time. The solution is shown by simulation to average 90-percent efficiency in that the instrument is transmitting or receiving (but never both) 90 percent of the time. This can be shown to be optimal, given the constraint that the number of echoes in flight needs to be constant over a sweep. This timing solution is the heart of an onboard processor/controller board for the second generation of Global Precipitation Mission.

The work is being done by Andrew Berkun and Mark Fischman of Caltech for **NASA's Jet Propulsion Laboratory***, with cooperation from consultant Ray Andraka. Further information is contained in a TSP (see page 1).* *NPO-30560*

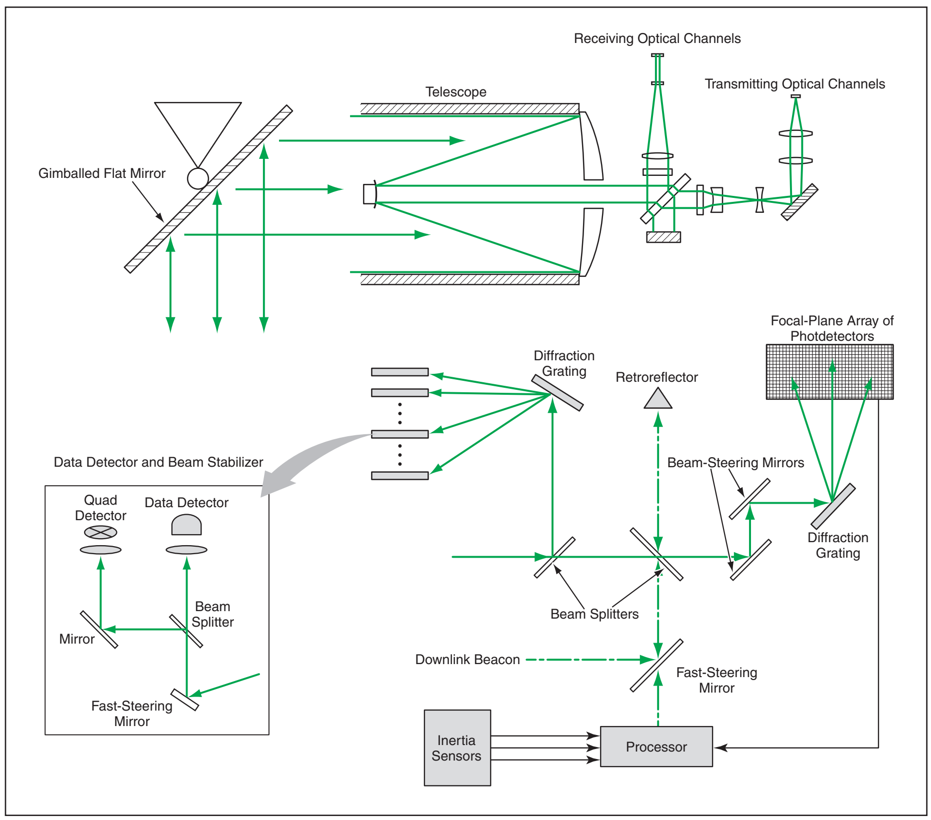
Concept for Multiple-Access Free-Space Laser Communications

Multiple terminals at lower altitudes would be tracked by optomechanical and optoelectronic means.

NASA's Jet Propulsion Laboratory, Pasadena, California

A design concept for a proposed airborne or spaceborne free-space optical-communication terminal provides for simultaneous reception of signals from multiple other optical-communication terminals aboard aircraft or spacecraft that carry scientific instruments and fly at lower altitudes. The concept reflects the need for rapid acquisition and tracking of the signals coming from the lower-altitude terminals as they move across the field of view.

As shown in the upper part of the figure, the optical train of the terminal would include a telescope aimed at the scene below via a gimballed flat mirror, which would be used to scan the field of view over a wide angular range. The lower part of the figure schematically depicts some of the optical and electronic channels used in the reception of data signals from, and the transmission of a beacon signal to, the lower terminals. This scheme is based on an architecture that provides for imaging of a small portion of the transmitted beam on a focal-plane array of photodetectors. Equipped with fast-readout circuitry, the focal-plane array would be used in simultaneous acquisition and tracking.



The **Optics and Electronics** in a higher optical-communication terminal would maintain communication with multiple lower terminals within its field of view.

The design concept includes an operational scenario in which each lower terminal would be assigned a unique uplink wavelength for its transmitted laser beam, which would serve as both its uplink communication beam and its beacon. An optical link would be initiated by a lower terminal, which would transmit a wide beam up to the higher terminal. The lower terminal would then await an acknowledgement of acquisition of its signal by the higher terminal before proceeding with a "handshake" and subsequent communications.

In the higher terminal, the uplinked beams from the lower terminals would be split between a data and a tracking channel, most of the beam power going to the data channel. In the tracking channel, the beams would then pass with minimal attenuation through a dichroic beam splitter and onto two electronically actuated beam-steering mirrors, which would reflect the beams onto a diffraction grating that would separate the beams by wavelength. The beams would then impinge on separate spots on the focal-plane array of photodetectors.

The downlink beam would be reflected by a fast-steering mirror, which would be driven to correct for vibrations measured by inertial sensors. The downlink beam would then be reflected out through the telescope by use of a mirror that would be partially (<1 percent) transmissive. The small part of the beacon beam transmitted through the mirror would impinge on a retroreflector and thereby be sent back to the focal-plane array to provide information on the pointing direction of the downlink beam.

The uplink from each lower terminal would be validated by means of the downlink beacon. To make this possible, the fast-steering mirror would also be made to rapidly scan the downlink beam across the locations of the lower terminals as indicated by the locations of their beam spots on the focal-plane array.

In the data channel, the uplink signals would impinge on a diffraction grating, then each beam would be focused on data-detector-and-beam-stabilization unit (denoted in the figure as d_i for the *i*th beam). Each d_i would include a quadrant detector and a fine-steering mirror acting together as parts of a servo loop to maintain strength of the uplink signal on a data detector.

This work was done by Keith Wilson of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

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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Refer to NPO-30621, volume and number of this NASA Tech Briefs *issue, and the page number.*

Variable Shadow Screens for Imaging Optical Devices

Effective dynamic ranges would be increased.

Lyndon B. Johnson Space Center, Houston, Texas

Variable shadow screens have been proposed for reducing the apparent brightnesses of very bright light sources relative to other sources within the fields of view of diverse imaging optical devices, including video and film cameras and optical devices for imaging directly into the human eye. In other words, variable shadow screens would increase the effective dynamic ranges of such devices.

Traditionally, imaging sensors are protected against excessive brightness by use of dark filters and/or reduction of iris diameters. These traditional means do not increase dynamic range; they reduce the ability to view or image dimmer features of an image because they reduce the brightness of all parts of an image by the same factor. On the other hand, a variable shadow screen would darken only the excessively bright parts of an image. For example, dim objects in a field of view that included the setting Sun or bright headlights could be seen more readily in a picture taken through a variable shadow screen than in a picture of the same scene taken through a dark filter or a narrowed iris.

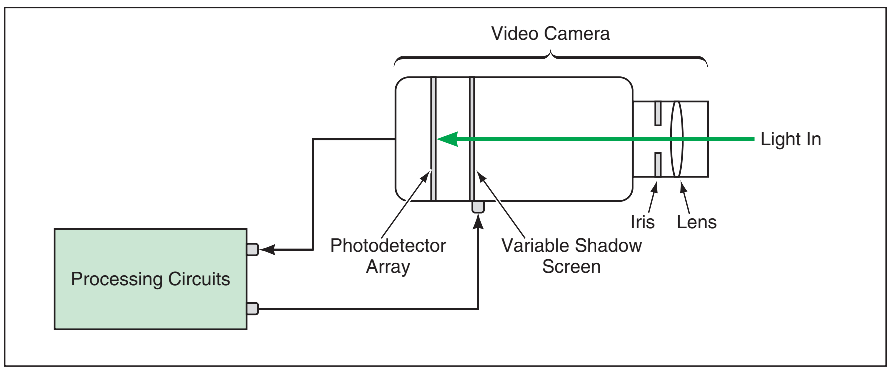

Image Feedback From the Focal Plane would be processed to generate a thresholded negative image on the shadow plane.

The figure depicts one of many potential variations of the basic concept of the variable shadow screen. The shadow screen would be a normally transparent liquid-crystal matrix placed in front of a focal-plane array of photodetectors in a charge-coupled-device video camera. The shadow screen would be placed far enough from the focal plane so as not to disrupt the focal-plane image to an unacceptable degree, yet close enough so that the out-of-focus shadows cast by the screen would still be effective in darkening the brightest parts of the image.

The image detected by the photodetector array itself would be used as feedback to drive the variable shadow screen: The video output of the camera would be processed by suitable analog and/or digital electronic circuitry to generate a negative partial version of the image to be impressed on the shadow screen. The parts of the shadow screen in front of those parts of the image with brightness below a specified threshold would be left transparent; the parts of the shadow screen in front of those parts of the image where the brightness exceeded the threshold would be darkened by an amount that would increase with the excess above the threshold.

This work was done by Ed Lu of **Johnson Space Center** *and Jean L. Chretien (an independent contributor). For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.*

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-23037.