duced errors, the risk can be made very small by use of a combination of very fast state-machine logic and error-detection logic. Therefore, one goal of two main elements of the present method is to design the fastest state-machine logic circuitry by basing it on the fastest generic state-machine design, which is that of a one-hot state machine. The other of the two main design elements is to design fast error-detection logic circuitry and to optimize it for implementation in a field-programmable gate array (FPGA) architecture: In the resulting design, the one-hot state machine is fitted with a multiple-input XNOR gate for detection of illegal states. The XNOR gate is implemented with lookup tables and with pipelines for high speed.

In this method, the task of designing all the logic must be performed manually because no currently available logic-synthesis software tool can produce optimal solutions of design problems of this type. However, some assistance is provided by a script, written for this purpose in the Python language (an object-oriented interpretive computer language) to automatically generate hardware description language (HDL) code from state-transition rules.

This work was done by Martin Le, Xin Zheng, and Sunant Katanyoutant of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-42401

Quasi-Optical Transmission Line for 94-GHz Radar

This apparatus functions as a very-low-loss, three-port circulator.

NASA's Jet Propulsion Laboratory, Pasadena, California

A quasi-optical transmission line (QOTL) has been developed as a low-loss transmission line for a spaceborne cloud-observing radar instrument that operates at a nominal frequency of 94 GHz. This QOTL could also readily be redesigned for use in terrestrial millimeter-wave radar systems and millimeter-wave imaging systems.

In the absence of this or another low-loss transmission line, it would be necessary to use a waveguide transmission line in the original radar application. Unfortunately, transmission losses increase and power-handling capacities of waveguides generally decrease with frequency, such that at 94 GHz, the limitation on transmitting power and the combined transmission and reception losses (> 5 dB) in a waveguide transmission line previously considered for the original application would be unacceptable.

The QOTL functions as a very-low-loss, three-port circulator. The QOTL includes a shaped input mirror that can be rotated to accept 94-GHz transmitter power from either of two high-power amplifiers. Inside the QOTL, the transmitter power takes the form of a linearly polarized beam radiated from a feed horn. This beam propagates through a system of mirrors, each of which refocuses the beam to minimize diffraction losses. A magnetically biased ferrite disc is placed at one of the foci to utilize the Faraday effect to rotate the polarization of the beam by 45°. The beam is then transmitted via an antenna system.

The radar return (scatter from clouds, and/or reflections from other objects) is collected by the same antenna and propagates through the Faraday rotator in the reverse of the direction of propagation of the transmitted beam. In the Faraday rotator, the polarization of the received signal is rotated a further 45°, so that upon emerging from the Faraday rotator, the received beam is polarized at 90° with respect to the transmitted beam. The transmitted and received signals are then separated by a wire-grid polarizer.

This work was done by Raul M. Perez and Watt Veruttipong of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-44236

Next Generation Flight Controller Trainer System

Lyndon B. Johnson Space Center, Houston, Texas

The Next Generation Flight Controller Trainer (NGFCT) is a relatively inexpensive system of hardware and software that provides high-fidelity training for space-shuttle flight controllers. NGFCT provides simulations into which are integrated the behaviors of emulated space-shuttle vehicle onboard general-purpose computers (GPCs), mission-control center (MCC) displays, and space-shuttle systems as represented by high-fidelity shuttle mission simulator (SMS) mathematical models. The emulated GPC computers enable the execution of onboard binary flight-specific software. The SMS models include representations of system malfunctions that can be easily invoked. The NGFCT software has a flexible design that enables independent updating of its GPC, SMS, and MCC components.

This work was done by Scott Arnold, Matthew R. Barry, Isaac Benton, Michael M. Bishop, Steven Evans, Jason Harvey, Timothy King, Jacob Martin, Al Mercier, Walt Miller, Dan L. Payne, Hanh Phu, James C. Thompson, and Ron Aadsen of United Space Alliance for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-23617-1