The Challenge: Developing a test system for establishing a satellite communications link and interrogating link quality.
The Solution: Using GPIB, DAQ, and serial protocols controlled by LabVIEW to provide real-time RF signal control, RF signal measurement, payload data generation, and bit error determination.

Introduction
In the early stages of developing the Iridium satellite-based personal communications system, Motorola came to ATG to develop a method to automatically establish a call between a subscriber (mobile) unit and a satellite.

Once established, users had to control the RF signal strength to and from the mobile unit to maintain a desired link margin at both the satellite and mobile receiver inputs. The parameters defining the quality of the wireless link are bit error rate (BER), missed frame rate, and signal-to-noise (SNR) ratio. To interrogate and log these parameters, we developed the Bit Error Rate Specialized Test Equipment (BER STE) system.

System Description
The BER STE software performs nine functions in round-robin fashion. The service loop executes in less than 90 ms to keep pace with the Iridium communication frame interval. The functions include:
• Reading from the mobile's datalog port
• Parsing link information from the mobile's data
• Generating voice data
• Receiving voice data
• Computing frame-by-frame BER
• Measuring mobile transmit power
• Calculating power received by satellite
• Adjusting uplink and downlink power to achieve the desired SNR at the mobile's and at the satellite's receiver inputs
• Logging link performance data to disk

The system maintains three independent serial ports, which control the mobile radio, reception of datalog information, and communication with the vocoder (voice) data port. We needed to develop a unique programming method to measure the mobile's transmit power from the peak power analyzer. Because of the analyzer's slow measurement rate – approximately 100 ms per measurement – we could not use conventional methods to implement the GPIB communications to this instrument.

To reduce the time impact that communications with the analyzer had on the test system, we segmented all queries for data into individual write and read operations. Only one operation executes per service loop cycle. When we query data from the instrument, the analyzer has 90 ms to make the data available at its output buffer.

Depending on the present state of the RF communication link, we must...
implemented a PN31 random sequence within the system software.

We developed a bit correlator in the LabVIEW software, which performs a correlation of a given received data packet to several prior transmit data packets and then selects the packet that resulted in the most probable data match. The system computes the bit error rate by comparing, bit by bit, the received data against the selected transmit data.

With LabVIEW, we can view test results from prior satellite passes by displaying link information in a graphical context. The information synchronizes with the state of the call and time of day so engineers can quickly ascertain potential causes of link quality degradation and other anomalies in the communication link.

**Results**

The BER STE system exceeded the performance expectations of the real-time test application. The National Instruments-based system significantly reduced development time because of its high-level language implementation and the ability to prototype system functions in a timely manner.

The ability to change directions on significant software designs that arose from system hardware shortcomings – for example, the GPIB interface to the peak power analyzer – generated significant cost savings. In addition to fast development time, the graphical nature of LabVIEW enhanced system value by providing an easy method of displaying the data to the user.

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dynamically vary the control of the mobile and other test system hardware to successfully maintain the call.

The state of the link falls into one of several call categories, including ring, broadcast acquisition, and traffic. We also implemented this control mechanism within the 90 ms frame structure.

To perform BER measurements, the satellite receives and transmits data to and from the mobile. Making BER measurements generates pseudo-random data on a frame-by-frame basis and then determines bit errors by comparing the received data against the data sent. For data generation, we implemented a PN31 random sequence within the system software.

With an aggressive timeline for the system, LabVIEW provided the best of both worlds – quick development time and ease of code modification.