DA SYSTEMS

Remote Data Acquisition Phones Home

Add cellular communications to a data logger, and you've made dialing for data and remote-site data acquisition much easier.

Steve Resweber, Synetcom Digital, Inc.

Sometimes it's not easy going to where the data are. But what if you could just dial up and get the measurements? The SynetCell Data Logger/RTU system (see Photo 1)—a new product for remote logging, monitoring, and control—uses cellular or standard telephone connections to access remote data. The system eases installation and operation across a wide range of industrial-site variables, including instrumentation interface types, power availability, environmental conditions, and communications preferences.

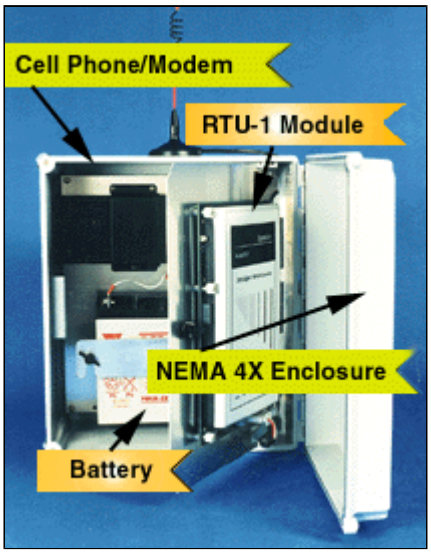

Photo 1. Housed in a weathertight NEMA 4X enclosure, Synetcom's SynetCell Remote Data Logger/RTU features easy access to all components. SynetCell communicates daily in a 1 min. cell phone call directly to your PC, delivering a summary of the previous 24 hr of sensor data. You can also call from any PC to see and control what's happening at the site in real time.

The SynetCell system (see Figure 1) incorporates remote-site and host-site elements. At the remote end, the hardware typically consists of a weathertight enclosure with an antenna and solar panel. The enclosure houses a battery, cell phone/modem, and the RTU-1 Data Logger/RTU module. Instrumentation (420 mA, voltage or digital interface) connects directly to the module, as do digital inputs and relay closure outputs. The host PC running Windows executes Synetcom's RadioLog software and, using a standard dial-up modem, can

field call-ins, poll designated sites, and reconstitute remote-site data into user data displays, Access databases, and alphanumeric pager messages to alert field technicians of potential problems.

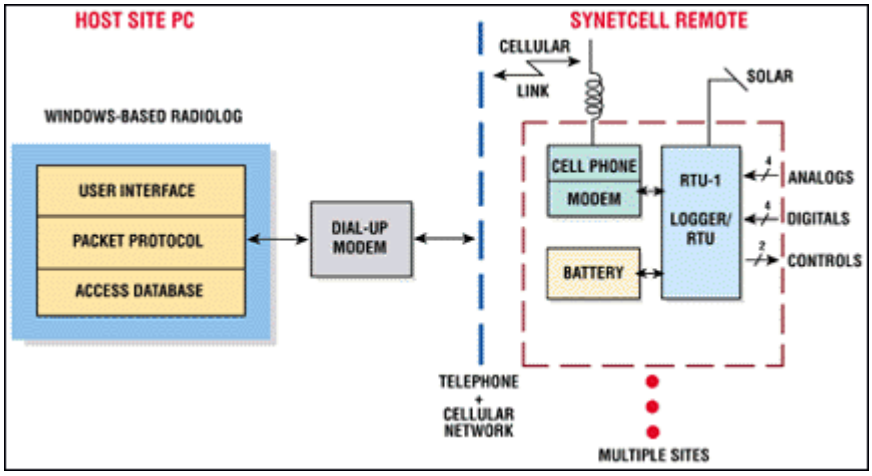

Figure 1. In the SynetCell system, the host-site PC (left) runs Windows software that logs phoned-in data to an Access database and alerts you to remote alarm conditions. You can place a call to any remote site (up to 10,000 per system) with a mouse click. On a miserly power budget, the remote site (right) draws <80 µA from a 12 V battery 99% of the time.

With the remote- and host-site hardware and software components that make up the multisite remote data logging/telemetry/ control system, SynetCell is a complete solution for many applications. Its host PC user interface displays current site parameters, exception conditions, and history summaries on screen. It also provides the database construct—you don't have to write any software. The generic database interface eases the implementation of custom or third-party applications for report generation, intranet interfaces, or other display interfaces, most of which can be constructed in Visual Basic to run concurrently on the host PC.

RTU-1 Data Logger

At the core of SynetCell's remote data acquisition (DA) capabilities is Synetcom's RTU-1 Data Logger/RTU module. Deployable as a stand-alone, 64 KB, four-channel data logger with four analog/digital inputs and two relay closure outputs, the module also offers RTU features and supports report by exception with internal drivers for various modes of wired and wireless communications (see Table 1). The unit's default configuration reads connected sensors (and checks for exceptions) once per minute and logs data once every 10 min. when there are no alarm or exception conditions. The logger is designed to monitor and log slower industrial processes, but if an exception develops, it will log

TABLE 1

REMOTE-SITE COMMUNICATIONS SUPPORTED BY RTU-1

- Cellular Modem

- Two-Way Telemetry Radio
- Trunked Radio
- Spread Spectrum Radio
- Packet Radio
- Telephone Modem
- Leased-Line Modem
- RS-232/RS-485
- Fiber-Optic Communications

the process more frequently. Therefore, logger memory is organized as eight nonvolatile 8 KB circular buffers. A history buffer and an event buffer are paired with each analog channel. In the pairing, the history buffer records data once every 10 min. (as above) for a total recording time of 52 days. The event buffer is activated only during an exception condition and records data once every 15 s, spanning up to 31 hr.

The module's built-in modem is compatible with two-way telemetry radios and trunked radios, and its interface connector (DB-15) supports the associated interface to the radio module. An RS-232 (DB-9) connector supports the additional communications modes, including cellular, and an expansion connector supports future module enhancements.

An inexpensive gasketted enclosure houses the module circuit board. Although not watertight, this approach greatly reduces exposure to humidity and corrosion. Outdoor deployment requires a NEMA-style housing, as is used with SynetCell. The unit has an operating temperature range of 40°C to 70°C and uses 12 VDC from an external battery, typically augmented with a small solar panel. The module features a convenient built-in solar regulator/battery charger, allowing direct connection to the panel.

Module I/O is internally protected against ESD, current overload, and RFI. Although not a traditional consideration in the selection of scientific data loggers, interface protection is an essential feature for industrial applications, especially where the logger becomes part of the long-term company infrastructure.

Cellular Communications

Cellular telephony has become an attractive medium for industrial remote-site communications primarily because of the wide availability of service, absence of FCC licensing issues, and decreasing airtime charges. Despite the push toward digital cellular telephony, which is currently less data friendly, most service is still analog and is based on the Advanced Mobile Phone Service system, operating between 800 MHz and 900 MHz. Coverage extends beyond metropolitan areas along all interstates and most secondary highways. But terrain radically affects the extent of cell site coverage; generally, only line-of-sight communication is reliable.

There are other alternatives that share the cellular spectrum and facilities, such as Cellular Digital Packet Data; however, deployment seems to be on a limited basis with no real impetus to accelerate availability (at least

until a consumer market develops). Nevertheless, the core RTU-1 module has been designed to interface with a multitude of communications (as summarized in Table 1).

Once a cellular call is established and the modems negotiate successfully, SynetCell communicates using packetized data constructs, with multiple fields containing analog readings (four channels), digital status (four channels), relay closure status (two channels), and other remote-site information. Reliable cellular data is obtained using an error-correcting protocol (which is supported by most high-end host modems) at a connection speed of 1200 baud. This may seem painfully slow, but even with the overhead associated with forward error correction in the protocol, complete site status is conveyed across the link in <1 s (cellular connections can at times support speeds as high as 9600 baud; however, Synetcom has found that across various systems and conditions, the 1200-baud connection proved much more reliable).

All packets use Cyclic Redundancy Check (CRC) error detection. If modem error control fails, the host software can detect errors in the SynetCell packet and decide whether to further process and display the data.

To ensure reliable cellular communications with SynetCell, select the antenna for the remote site carefully. A simple whip antenna usually does not suffice, as Synetcom learned in early SynetCell installations.

The cellular infrastructure provides for handoffs, where a call is transferred from one base station to another, based on relative signal strength and other system considerations. A mobile cellular caller usually benefits from a handoff because the call is fielded by the nearest base station with the strongest signal.

The full-duplex audio channel is interrupted for a moment during a handoff, hardly affecting a voice conversation. Cellular modem protocols can also deal with a handoff, provided it does not occur during initial modem negotiation—then the call is almost always dropped.

For fixed-site operation, a directional antenna pointed toward the strongest base station greatly reduces the cellular system's propensity to hand off a call and can improve the negotiation success rate. A six-element yagi-style antenna is recommended. These are larger than a whip (~2 ft boom length with coplanar elements) and are mounted so that the elements are vertical. Local cellular carriers often offer on-site assistance with pointing the antenna correctly.

Low Power Consumption

One of the most important considerations for unattended remote-site operation is low DC power consumption. In quiescent mode, SynetCell draws 80 µA from a 12 V battery. Low power consumption combined

with cellular communications translates into smaller batteries and solar panels and makes remote-site deployment feasible in areas previously considered impractical for monitoring and control.

The RTU-1 realizes low power consumption by using a dual-processor architecture and careful power management. The associated power consumption is proportional to processor speed. A slower CMOS processor is used for less demanding tasks (e.g., timekeeping, module event scheduling, sensor reads, and power management), realizing 80 µA consumption close to 99% of system operation time. The faster processor is powered up when communication is necessary, and it assumes the task of managing modem sessions and reporting site activity. During this time, the module consumes 60100 mA.

The 3 W cell phone transmitter consumes 2 A; however, this is limited to a typical 1 min. call, after which, depending on the configuration, the phone is powered off or remains receptive to incoming calls for a preset period of time (at a much lower power drain of ~100 mA). Furthermore, sensor power is strobed on with an adjustable stabilization time—prior to and during a sensor read only—further economizing on-site power consumption.

Site Interfaces

Recently introduced features compatible with SynetCell have been designed to enhance connectivity at the remote site. A wireless connection between the RTU-1 module and site instrumentation (no FCC license required) is now possible using the company's Wireless Interface Site Expander (WISE) system.

On the sensor side, the WISE transmitter accepts a 420 mA or voltage input and provides a contact closure for gating power to the sensor, presumably from a 1224 V battery. The module periodically strobes power on to the sensor and digitizes the reading, which is then transmitted (typically as far as 1000 ft) using a radio frequency frequency-shift-keyed transmission back to the WISE receiver. The receiver holds the data until the RTU-1 wakes up to do a sensor read. WISE then delivers the data to the RTU-1 in digital or analog form for logging and further transmission via cellular communications to the host. The same type of CRC is applied to WISE packets to guarantee data integrity.

SynetCell also supports connection to digital sensors (see sidebar). A MODBUS-compatible port has been added to the RTU-1 to facilitate interfacing with digital instruments and PLCs. WISE also uses the port for interfacing. Currently, the Honeywell Digitally Enhanced (DE) proprietary protocol is supported via an internal module that translates DE values into MODBUS write register commands. Drivers for other interfaces that use Hart and Fieldbus are anticipated by this spring.

Applications

SynetCell and the core RTU-1 Data Logger/ RTU have been designed for deployment at industrial sites in a wide range of industries. Current applications include pressure recording/monitoring for gas utilities and pipeline companies, monitoring methane concentration in coal mines, and measuring magnetic fields at electric utility facilities. The common thread through these applications is the need for a combination of data logger functions and RTU/communications features in one integrated, cost-effective system.

The WISE system is especially well suited for structure instrumentation, as used in bridge monitoring (typically tilt meters and strain gauges). The bridge is outfitted with instrumentation that reports back via wireless communications to one or more bridge-central WISE/RTU-1 modules for logging, exception checking, and ultimately reporting to a central host site using cellular communications. A typical SynetCell remote unit with solar panels and a NEMA 4X enclosure sells for approximately $2500. The core RTU-1 Data Logger/RTU starts at $750.

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SynetCell in the Real World

George Hodges, Duke Energy, Inc.

Duke Energy operates a gas storage field with 80 active storage wells in rural western Maryland. Duke originally installed Synetcom Digital's RTU-1 as a stand-alone data logger to collect pressure data during the testing of the storage wells. As a secondary function, the unit gathers pressure data from key locations in the field and sends it to the local field office via cellular telephone for the daily reports.

The data are used to monitor the pipeline efficiencies during the gas withdrawal cycle. As the withdrawal season progresses, reservoir fluids accumulate in the pipelines and reduce the pipeline efficiency. Duke uses SynetCell to determine how fast the fluids accumulate and how often they must be removed to optimize pipeline efficiency.

The SynetCell remote units were factory tested as a complete system before they were shipped to the field locations. Once the units arrived in Maryland and were installed at the sites, Duke had a few problems getting the cellular phones to work correctly, but the problems related primarily to activating the phones with the local cellular carrier. Synetcom worked with the local carrier and Duke field personnel to resolve the problem.

The system has been reliable, even when faced with difficult operating parameters. For example, one of the remote sites is in a deep valley, and Duke was concerned about getting reliable cellular data from the location. But there have been no problems to date. In fact, cellular communications have worked well from all the sites. This was seen as a validation of Synetcom's cellular implementation as well as the concept of telemetry via cellular technology. Currently, the SynetCell units call into a PC in a local field office once a day. The PC is on a network, and the daily database file created by SynetCell host software is available to anyone on the network, including engineers in the Texas office.

Remote DA and transmission is not new to Duke. However, for this type of application, these products are difficult to justify if the cost is high. SynetCell provides a good way to collect field data at a reasonable cost.

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