Building a Perfect Industrial Telemetry System

Seven Key Features of All-in-One GPRS Data Acquisition Solutions

Stanley Liu

Product Manager/Data Acquisition & Control Division

Overview

This white paper will explore the challenges of developing telemetric SCADA systems and cover the seven most important features to look for in selecting a GPRS solution.

Telemetric Supervisory Control and Data Acquisition (SCADA) systems promise tremendous efficiency and reliability advantages for remote industrial operations, but their implementation can seem a daunting challenge. Telemetry and wireless technologies have made monitoring systems possible in applications that were previously too remote or distributed for conventional cabling. However, in building or expanding a wireless system, system integrators must confront new and possibly unfamiliar technologies and challenges. This white paper will examine common obstacles in developing wireless SCADA systems and explain the seven key features of successful, cost-effective, and reliable GPRS data acquisition solutions.

An Archetypical SCADA Application

A pipeline system is an excellent example of a distributed SCADA application that benefits from telemetry. There are many industrial applications with similar remote requirements.

This white paper will use a hypothetical pipeline system to illustrate the various problems and decisions involved in creating a remote SCADA system. The same telemetric technologies and solutions used in this pipeline system are equally relevant to distributed industrial applications such as street and traffic light grids, agricultural irrigation, energy utilities, flood detection, or any other system that requires the remote monitoring and control of many devices.

Released on

Copyright © 2009 Moxa Inc., all rights reserved.

Moxa manufactures one of the world's leading brands of device networking solutions. Products include industrial embedded computers, industrial Ethernet switches, serial device servers, multiport serial boards, embedded device servers, and remote I/O solutions. Our products are key components of many networking applications, including industrial automation, manufacturing, POS, and medical treatment facilities.

How to contact Moxa

Tel: 1-714-528-6777
Fax: 1-714-528-6778
Web: www.moxa.com
Email: info@moxa.com

This document was produced by the Moxa Technical Writing Center (TWC). Please send your comments or suggestions about this or other Moxa documents to twc@moxa.com.

A pipeline system is used to transmit liquids such as water, oil, natural gas, and pulp over long distances. There are many pipeline control and monitoring points distributed throughout the length of the system. The remote monitoring system collects data from these points regarding pipeline pressure, flow rate, and other real-time information and transmits it to the control center. This empowers the system operators with a comprehensive awareness of the entire pipeline, which allows targeted maintenance, improved response times, and an overall reduction of system failures, interruptions, and maintenance costs. Further system refinements are made possible by data collection and analysis, which can identify potential trouble spots and bottlenecks for specific attention.

Challenges in Deploying a Remote SCADA System

Wired communications is simply unsuitable for a distributed remote SCADA system such as a pipeline. GPRS communications is a much more flexible solution.

By definition a pipeline system will span substantial physical distances in order to fulfill its function. The various data acquisition and control points are distributed throughout the length of the pipe in the field. This presents obvious difficulties for a wired communications solution. Paving, wiring, and leasing lines from telecom carriers can quickly escalate costs to prohibitive sums. The dial-up process will be slow, and operating costs of maintaining the lines will be high. Finally, geographical limitations may make it outright impossible to deliver wires to certain locations. Wired communications is simply unsuitable for a distributed remote SCADA system such as a pipeline.

In contrast, a GPRS communications system is very flexible. It requires less investment in capital or deployment time and is easier to maintain for greater overall cost-effectiveness. However, even with the convenience of GPRS-powered communications, every SCADA system is complex. Multiple on-field devices, such as a pipeline system’s flow meters, pressure gauges, thermometers, and water quality analyzers, must be integrated and reliably monitored. In order to build or maintain a resilient, stable, and long-lasting system,

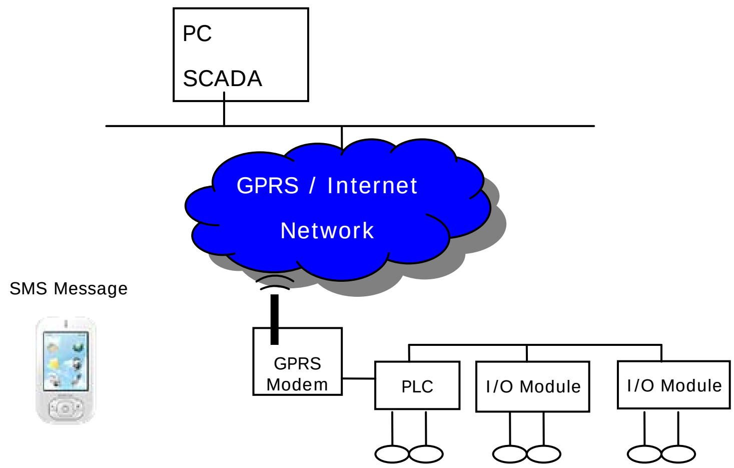
Copyright © 2009 Moxa Inc.

developers need to possess a broad set of skills, including an understanding of wireless communications, control procedures, communications protocol conversions, and how to write control system software.

A Typical GPRS System

A typical GPRS system can be divided into 3 components: front end, back end, and SMS.

A typical GPRS system architecture is presented below. The entire system can be divided into three major components: the site equipment and devices located on-field, the monitoring host computer located at the control center, and finally an additional SMS connection for mobile alerts.



The first section, often referred to as the "remote terminal" or "front-end," includes the devices in the field, such as data acquisition devices that monitor pipeline flow, pressure, temperature and any other measurements that are required by the application. These devices are then connected to I/O modules and processed by a programmable logic controller (PLC) located on the field, which is a bridge between the field devices and the control center. The PLC control and monitoring terminal collects status data and is responsible for communications and automation. Additionally, alarm messages can be sent out when preset parameters are met. As the remote field sites are generally unmanned, terminal performance and resilience are important factors in the overall reliability of the system. Finally, a GPRS modem connects these field devices wirelessly with the rest of the system.

The second part of the system, often referred to as the “SCADA software” or “back-end,” is the control center where the host computer monitors and evaluates the data constantly arriving wirelessly from the field. More complex information management such as graphical HMI displays or historical data archiving and analysis is made possible by the more sophisticated host computer. This allows operators to have a holistic view of the health of the entire pipeline system, anticipate potential problems, optimize maintenance efforts, and otherwise ensure the pipeline operates at maximum efficiency.

The final part of the system is the real-time alarm component, which gives the system an additional means with which to keep system operators constantly aware of the pipeline’s status wherever they are. Deploying an SMS alarm system ensures that system operators will be notified of urgent information via SMS messages even if they are not in the control center.

Common GPRS Hurdles

Smoothly coordinating the activity of many different devices is a challenging task, and there are many obstacles before a GPRS SCADA network is up and running.

Once deployed, a telemetric SCADA system using GPRS is an invaluable tool to improve the reliability, efficiency, and safety of a pipeline network. However, there are substantial hurdles to overcome before a GPRS SCADA network is up and running smoothly. For example, GPRS communications present unique connectivity issues, as often only dynamic IPs are available for GPRS devices. The bandwidth consumption of the GPRS network must also be controlled to minimize access charges. Additionally, the plethora of different devices at a field site can quickly create overwhelming development costs. The many system components at the field site must all be configured and tested so that they communicate seamlessly. For example, just the connection between the PLC and the GPRS modem requires the appropriate settings, driver, and interface before it is functional. Specific development is also required for the PLC’s

Copyright © 2009 Moxa Inc.

connection with each of the various I/O devices used: alarms, control equipment, data acquisition, and data storage. Even after all this development is complete, it is still necessary to conduct thorough integration testing to ensure that the system runs smoothly as a whole. Although some products do provide advanced tools to assist in program development, developers still need substantial expertise in this particular field to build a successful system.

Towards Integrated Solutions: Seven Key Things to Look For

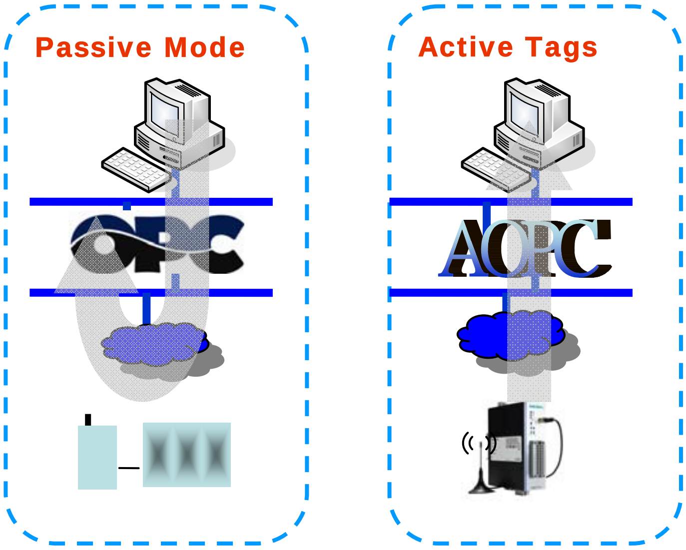
Using integrated RTUs is an excellent way to reduce the complexity and cost of building GPRS systems. To obtain the greatest value, ensure that the RTU product has the following features.

Increasingly, system builders are responding to the hurdles outlined above by turning to integrated all-in-one GPRS solutions: Remote Terminal Units (RTUs). By combining multiple front-end functions, including the GPRS modem, alarm, PLC, data logger, and device I/O, on one device, an integrated solution can reduce the complexity of a GPRS system and consequently offer substantial efficiency and reliability advantages. However, not all RTUs are created equal. Before selecting an all-in-one GPRS device, make sure that the product can deliver the following seven key features:

Flexible and Efficient Host-Client Communications

An RTU that allows fine-tuning of its communications behavior will allow users to consume precisely the amount of bandwidth needed—no more and no less. This conserves network usage and reduces GPRS service charges.

Broadly speaking client-host communications can be divided into two categories. In polling architecture, the host computer (control center) will send queries to each client (remote terminal) in turn, and receive data in response. In active, or push, architecture, clients will initiate contact with the host. This can be set to trigger on the occurrence of specific events. Polling architecture results in consistent and predictable host-client communications and has been very common in industrial automation in the past, and there are a number of different protocols for its implementation, such as Modbus/TCP and Siemen's profi-bus. However, in a GPRS environment there are additional considerations that alter the assessment of network architectures. Compared to a wired network, the data transfer rate of a GPRS network is relatively low, with a theoretical peak of 172.2 Kbps and about 20 to 40 Kbps available in general use. Additionally, in GPRS networks the IP address of terminal equipment is often not fixed.



In this environment polling architecture's shortcomings become apparent. In order for the host to access the client terminal, it must have a fixed IP, which is often not possible in a GPRS network with private IPs. Workarounds for this issue such as VPN service, dynamic domain name resolution, and public fixed IPs, are problematic, an additional cost, and limited by carrier availability. Moreover, polling architecture is restricted by its time and bandwidth-consuming nature. If the interval between polling queries to each client is set too long, then the cycle may miss important events until it is too late. However if the interval is set too short, then responses could be lost with constant re-connections.

Active/push architecture is well-suited for GPRS networks, and a flexible active architecture is a key component of an effective RTU. The client takes the initiative to connect to the host computer, so only the host computer needs a fixed IP; the

Copyright © 2009 Moxa Inc.

client can have a dynamic or private IP without any issues. Additionally, instead of responding to host queries on a fixed schedule, a remote smart terminal can decide when information should be reported to the control center. This design saves packet traffic yet also ensures that the host is notified immediately of any events that require a response.

Broad Connectivity Options

The integrated solution should be able to manage varied and numerous field devices, such as sensors, pipe flow control, and water quality analyzers. The serial interface is the most common interface for industrial devices, so the integrated RTU will need serial ports available to connect those devices to the SCADA network. However, merely having an available port is not enough; industrial devices communicate using many different communications protocols. Seek a GPRS solution that is versatile enough to handle a diverse range of devices without imposing onerous development demands on system builders. Specifically, the ability to create transparent serial channels to the control center and advanced protocol conversion functions will reduce the complexity of connecting field devices to the SCADA system.

Reliable Alarm System

The most critical requirement of any alarm system is timeliness. It does no good for system operators to receive detailed and accurate system alarms if those alerts have come too late for an effective response. An RTU that includes a front-end alarm system that is real-time and versatile will ensure that technicians and staff receive system alerts promptly and reliably

A front-end unit that can initiate alarms possesses obvious advantages over ones that rely on the host PC in the control room to process data and then generate alarms. The transmission between client and host could be delayed, interrupted, or lost entirely, which is unacceptable for a potentially mission-critical alarm. There are additional

Copyright © 2009 Moxa Inc.

advantages if the RTU has a built-in clock and can timestamp alarms and alerts on the front-end, rather than relying on the host PC to record the times. Due to network delays, timestamps from the back-end will never be as precise as timestamps that are applied at the front-end, where the data is gathered. Timestamps recorded in the RTU can be periodically uploaded to the host for more accurate real-time analysis and processing.

Also ensure that the RTU possesses versatile alarm messaging. Selecting a unit that can deliver messages via SMS, email, TCP/UDP, SNMP, or updates to the SCADA system, allows system operators to receive critical information in any circumstance, in the most appropriate format and medium.

Intelligent Autonomous Control of Field Devices

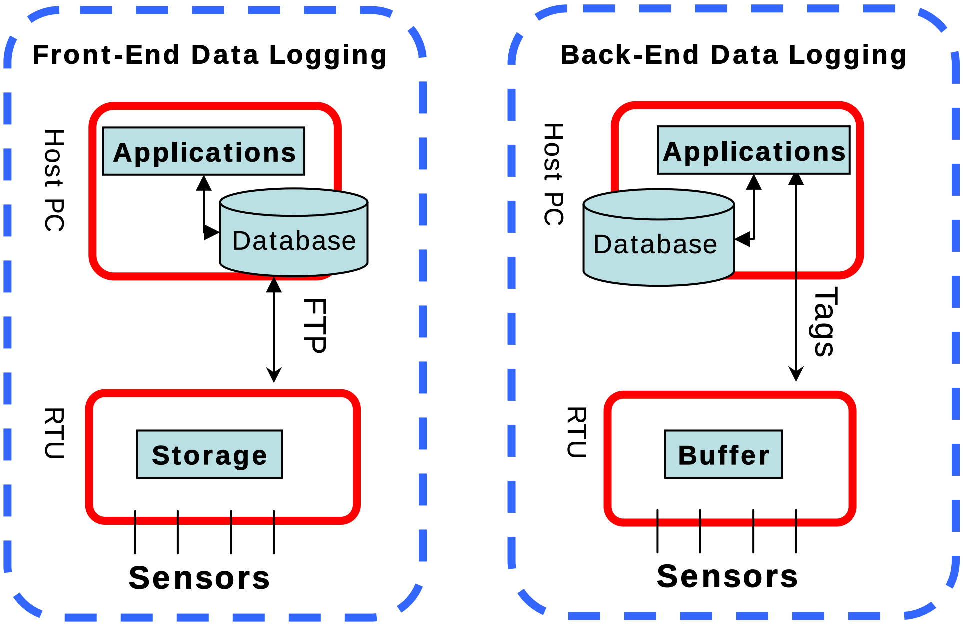
Verify that your RTU can easily be configured to respond to certain events in the field with or without operator intervention from the control room. Allowing the system operator to adjust field devices from the host PC substantially speeds response time compared to sending out a maintenance team. However even this expedited response could be insufficient in some urgent situations, such as an imminent critical pipeline leak. In these sort of pressing circumstances the RTU should be able to automatically adjust devices to close valves and address the situation, and then issue alerts to inform system operators.

Front-End Data Logging and Storage

A SCADA system relies on consistent and trustworthy historical data in order to build analysis and prediction models. There are two common approaches to storing log data in a SCADA system: back-end and front-end. In back-end storage, the remote terminal sends data to the central host PC continuously, where it is then stored. In front-end storage, the RTU has storage capacity built in, so the data can be recorded as files in local memory, which is then regularly copied to the host computer.

Copyright © 2009 Moxa Inc.

In a GPRS environment, in order to conserve bandwidth, average, rather than real-time, values should be transmitted, even when using back-end storage—for example, rather than continuously transmitting flow data, the RTU can intermittently transmit the 5-minute pipeline flow rate average. Furthermore, back-end storage is vulnerable to network interruptions, in which case the data being transmitted from the remote terminal could be lost without ever being stored. A front-end storage solution ensures that all data is logged to a local file regardless of network conditions.



- Object: File
- Complete data records
- Not real-time

- Object: I/O tags
- Will miss data when communications loss
- Real-time

Low Power Consumption

The basic challenge of supplying power becomes nontrivial at remote field sites and substations. If the remote site requires abundant power and the attendant cables to supply that power,

Copyright © 2009 Moxa Inc.

some of the advantages of employing wireless cellular communications in the first place have been lost. Indeed, it might be physically impossible to supply power via cables to some field sites. Instead, a combination of solar and battery power is an excellent choice for distributed remote networks. This combination allows the battery to help compensate for variations in available solar energy due to time of day or year. Unfortunately, battery costs can rise quickly if the system requires higher capacity batteries. Compromising on battery quality is a poor option as well, as that creates shorter battery replacement cycles and increased maintenance requirements. Selecting equipment that is designed for low power consumption will minimize the headaches and costs involved in supplying power to remote sites.

Easy-to-Use Software Tools and Integration

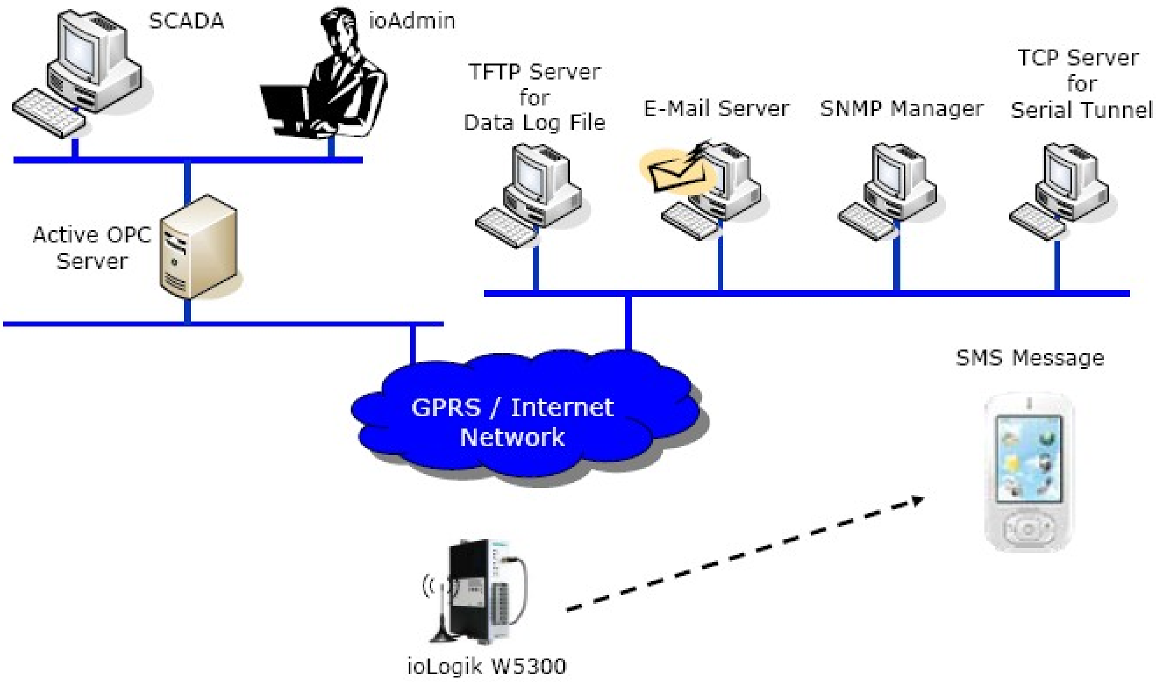
Many RTU providers believe that system integration ends with hardware, and consequently they neglect to address the software integration side of things. An RTU that integrates many hardware components into one device may seem like an excellent solution, but without corresponding software support this complex device is a recipe for disaster. An RTU with easy-to-use software tools will obviate the need for lengthy and resource-intensive software development and maintenance. Ensure that the RTU provider understands a basic but often overlooked principle: to deliver customer value, hardware and software should go hand in hand

Moxa's Highly Integrated All-In-One RTUs

The ioLogik W5300 series is an RTU that offers some notable design advantages. Its highly integrated design simplifies the creation of GPRS systems.

Moxa's ioLogik W5312 and W5340 Active GPRS RTUs are highly integrated complete solutions for remote data acquisition. A GPRS module, device I/O, active push architecture, software tools, alarm system, and data logging are all integrated into a compact, all-in-one product. This comprehensive solution delivers all of the benefits outlined in this paper to increase the effectiveness and reduce the costs of a telemetric SCADA system.

Copyright © 2009 Moxa Inc.



Moxa's seamlessly integrated hardware and software solution also provides the following unique advantages:

Compact Design

ioLogik W5300 series RTUs are housed in a 13 x 10 x 5 cm aluminum chassis. This compact design dramatically reduces installation space requirements and allows the ioLogik W5300 to be installed nearly anywhere. Additionally, the tight integration of the various components reduces the number of points of failure compared to an assembled PLC solution.

Interoperable with Existing Systems

Because it can use active push architecture, the ioLogik W5300 series overcomes any limitations of your existing carrier—a new station can be added to a GPRS network as soon as a SIM card is inserted. The ioLogik RTU also has serial connectivity available, making it easy to communicate between serial field

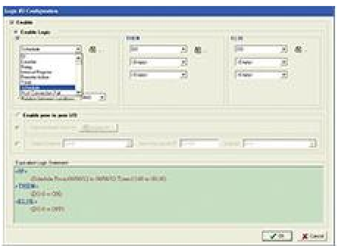
Copyright © 2009 Moxa Inc.

devices and a host PC.

Customizable Data Communications

Being able to fine-tune communications behavior allows users to tailor communications to specific applications. The ioLogik W5300 series can be user-customized to use a specific communications protocol and report at a set frequency, according to the particular requirements of any given application. The table below illustrates some common usage scenarios, and their corresponding packet size and frequency. For example, to implement on line real-time monitoring using Moxa's Active OPC server, the ioLogik W5300 series product reports to the host PC every 10 minutes with a packet size of about 394 bytes for 1.7 MB of data traffic. Alternatively, in a scenario where less frequent monitoring is acceptable, the RTU can send a 160 character SMS message 10 times a day. By evaluating their own requirements, users can determine the optimal reporting behavior and calculate the most suitable data plan for their application.

Strategy	Packet Size	Frequency
Online real-time monitoring	394 Bytes	Once every 10 min.
Update data logs once a day	1 MB (Typical) 13 MB (Max)	Once per day
Report by Exception	200 chars	Once per day
SMS Phone Reports	160 chars	10 messages per day



Intuitive Development Environment

The ioLogik W5300 series uses an intuitive, menu driven IF-THEN-ELSE development environment to configure the unit's behavior. Even untrained engineers can quickly configure the reporting mode, frequency, and triggers of an ioLOgik W5300 series RTU using this powerful yet easy-to-use software tool.

Copyright © 2009 Moxa Inc.

Conclusion

Moxa's ioLogik W5312 and W5340 Active GPRS RTUs are ideal solutions for distributed data acquisition and control systems, such as water, wastewater, flood warning, security, weather, traffic control, irrigation, oil, and pipeline systems. To find out more about the products in the ioLogik W5300 series, or to request pricing information, visit: http://www.moxa.com/Event/Net/2009/ioLogik_W5312/index.htm

Disclaimer

This document is provided for information purposes only, and the contents hereof are subject to change without notice. This document is not warranted to be error-free, nor subject to any other warranties or conditions, whether expressed orally or implied by law, including implied warranties and conditions of merchantability, or fitness for a particular purpose. We specifically disclaim any liability with respect to this document and no contractual obligations are formed either directly or indirectly by this document. This document may not be reproduced or transmitted in any form for any purpose, without our prior written permission.

Copyright © 2009 Moxa Inc.