WHITE PAPER

Real Time Remote Monitoring over Cellular Networks

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Introduction

For distribution infrastructures located in remote, isolated areas, unmanned monitoring systems have long been constrained by the limitations of long range communications. Traditionally, radio communication was used as part of the solution, and even though this communication medium has proven cost-effective, a significant disadvantage was the limit imposed by available data transmission speeds, the long transmission times, and the increased possibility of data loss as the transmission area expanded.

The advent of advanced cellular communications technology has loosed system integrators from each these restrictions, delivering new potential for remote monitoring solutions. By carrying monitoring and control communications over cellular, engineers can build a remote management platform that is easy and economical to deploy, minimizes site visits for configuration and maintenance, and can reliably deliver in real time both high bandwidth applications like video surveillance and critical low-bandwidth alarms.

Challenges and Solutions

In this paper we discuss the technical challenges inherent in remote data acquisition, with special emphasis on applications that involve the monitoring and control of data from extremely distant pipeline, pump, and wayside equipment. We first consider what is involved in deploying a cellular communications system for remote monitoring, and the critical features and functionality required to make this a viable solution. The following topics are covered:

- Why Cellular?
- Dynamic Versus Static IPs
- Active Data Transmissions:
  - Optimize Bandwidth
  - Avoid Timeouts
  - Streamline Data Acquisition Layers
  - Reduce Maintenance Costs
- Guaranteed Data Integrity

Why Cellular?

When using radio communications for pipeline management, system administrators typically configure Remote Terminal Units (RTUs) to log data in local storage devices and then send maintenance personnel site-to-site to collect the data. Since data is not transmitted in real-time, implementing high bandwidth applications such as video surveillance carry resource

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management difficulties that are often insurmountable, while costly resources must be allocated to collect and parse the data from the remote sites. Consequently, system architects are now turning to cellular communications for a more flexible and efficient communication platform.

The beauty of cellular technology is that it can serve IP networks, and since the vast majority of field devices are now IP-enabled it is possible to carry all manner of field data over cellular links. But using IP communications alone is not enough, because bandwidth and latency are also important considerations. Since cellular networks transmit over much greater distances than traditional radio and microwave communication interfaces, the number of communication relay nodes required is much reduced in comparison to radio or microwave systems. Moreover, with cellular’s much expanded bandwidth and improved resistance to interference and by using the communication infrastructure already installed by cellular providers, far fewer relay points are required, allowing system operators to reduce infrastructure expenses even further.

With the recent transition from GPRS to HSPA, cellular technology has recently seen dramatic improvements in bandwidth and network latency. Maximum bandwidth for cellular uplinks can currently reach 5.76 Mbps, and the downlink bandwidth can reach as high as 14.4 Mbps. Cellular latency has also been significantly reduced, with some networks reducing latency to times as low as 100 milliseconds. The bottom line is that today, in every respect cellular performance now exceeds almost any other long-range communications technology available.

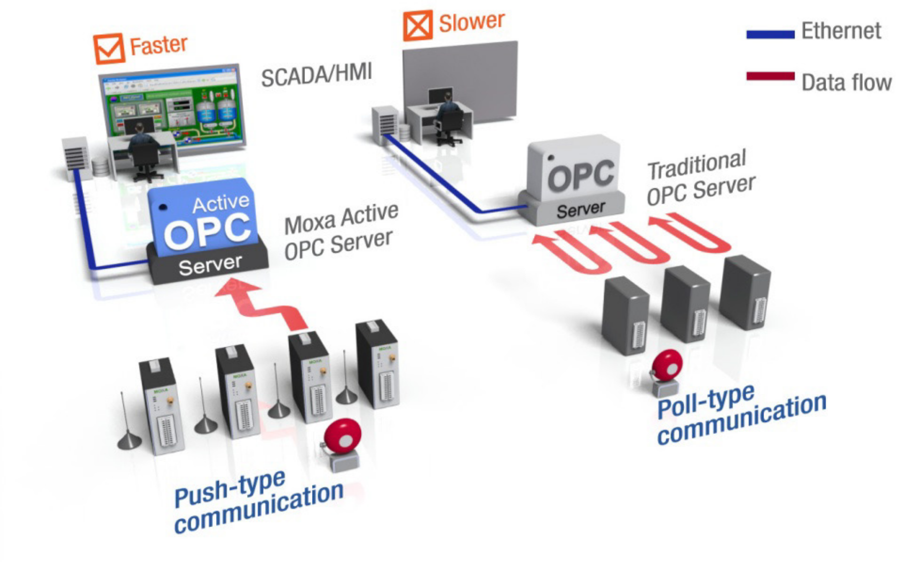
Dynamic Versus Static IPs in Remote Data Acquisition

In order to establish bi-directional communications (so the central site may directly query the data loggers, and vice versa), it is best if both the cellular modems at the remote sites and the SCADA server are assigned static public IPs. However, since cellular network carriers charge higher fees for static IPs than they do for private, dynamic IPs, this setup can quickly get extremely expensive.

Using appropriately featured OPC software, however, it is possible to configure a remote device to automatically register itself with a central SCADA that uses a fixed IP. In this way, the SCADA will receive and register the remote device’s IP address and be able to deliver or record tag updates accordingly. This arrangement is a very easy and cost effective means of managing remote devices over cellular. In addition to using device registration with an OPC server, it is also possible to use dynamic DNS registration, where the remote device converts its dynamic or private IP to a DNS hostname (i.e., a URL). In this way, the central software only needs to have a database of URLs to connect to a remote HSPA device.

Active Data Transmission Optimizes Bandwidth Usage and Helps Eliminate Communication Timeouts

Once the user decides to use cellular communications, one of the most critical and obvious questions is "how much will it cost?" In a traditional automation-centric environment, operators use devices like PLCs to retrieve data, and in this case bandwidth is not an issue since the PLCs are typically part of a local, wired infrastructure. However, for remote applications over cellular, bandwidth costs money, and is a big concern. Polling architectures are, therefore, poorly suited for cellular networks.



Active push communications significantly reduces network overhead, and will cut the costs associated with deploying a cellular system. Push communications cuts network overhead by eliminating the need for server polling, thereby cutting network overhead significantly. Without being polled, remote devices actively send data to the central server on their own initiative. Thus, the only time data is acquired from sensors or alarms is when an event occurs at the site, whereupon the change in data is "pushed" to the control system database, where the operator can then apply the reports.

With active reporting, the central server or SCADA does not need to constantly interrogate field devices for data: instead, it just waits for incoming data. Active reporting not only reduces bandwidth usage, it also makes real-time alarms possible. Almost as importantly, with active reporting it is possible to dynamically adjust communications margins to accommodate the network's timeout tolerance, and prevent timeouts from occurring at all.

Communication timeouts over cellular networks can easily become an expensive problem. Both Ethernet and serial field devices use remote polling to acquire data. A device whose communication timeout value is set to accommodate LAN communication speeds will face timeout issues when deployed on a cellular network. Repeated communication timeouts will crash the system, and will incur additional bandwidth fees with each reconnection attempt. An active push architecture that creates data reports solves this problem, since replacing constant data polling with active reports allows the system to actually eliminate the possibility of communication timeouts.

Active Reports Streamline Data Acquisition Layers and Reduce Maintenance Costs

Traditional polling systems often require multiple data acquisition layers. This multi-layer architecture is designed to spread the system load and shorten the polling cycle. However, multi-layer systems are difficult to manage and complicated to design and maintain. In large systems, a problem that occurs at an intermediate node will take a lot of time to locate and troubleshoot. In addition, a large multi-layer system is often cobbled together by different system integrators, each using different equipment and different protocols. Protocol unification alone can cause enough problems to cripple the entire system.

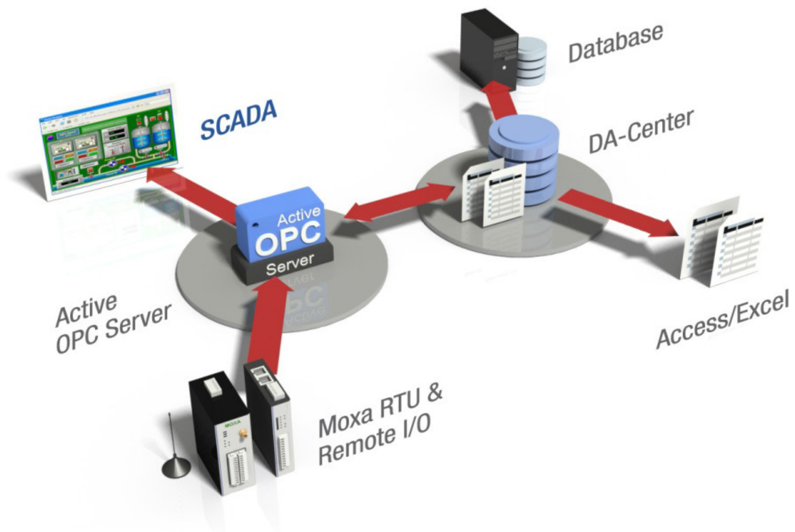
The development of cellular data acquisition and alarm systems that use active reporting technology has made it possible to eliminate almost all intermediate data acquisition layers. Since cellular networks are IP based, they have essentially no distance limitations compared to traditional radio or microwave communication interfaces, and the required number of communication relay nodes is reduced. Since the system uses the communication infrastructure created by the cellular provider, there are significantly reduced infrastructure costs, as well. What's more, cellular network bandwidth is significantly wider than RF and less vulnerable to outside interference, so fewer data acquisition relay points are required.

Efficient, Effective Programming for Improved Remote Monitoring

For complex algorithms, nothing provides greater flexibility than an effective programming platform. The programming platform is used for applications that require the highest level of programming versatility, such as custom protocols, complex calculations, and data logging. Programmable cellular RTUs which provide C/C++ or IEC 61131-3 compliant programming support (which includes the Linux tool chain) can be efficiently customized to easily meet a wide variety of user needs. The programming environment helps users economize installation and configuration times by reducing programming overhead for key areas such as I/O control, alarms, and network communication controls, which in turn include cellular connections and SMS, as well as interoperability with current SCADA/DB systems. Compared to other programming platforms, Linux and IEC-61131-3 compliant cellular RTUs deliver maximum coding flexibility, and when optimized with ready-to-use SDKs the setup of I/O control and alarming becomes easier and faster than ever before.

Efficient Database Uploads to Provide Data Consistency

Being able to establish real-time data acquisition in a remote environment that has an unreliable communication infrastructure is important, since operators need real-time information to make decisions that affect resource allocation and delivery. Traditionally, operators would use data loggers to store event information (for PLCs, the data stored is the entire data-set received from polling over a particular time period), with the information retrieved manually during site visits. This is a highly inefficient way of managing remote sites, particularly since it can lead to overlaps in data retrieval and create multiple network layers for operators to sort through.



By combining cellular communication with event-based data acquisition operators will get direct, real-time access to all remote data. For this reason, database optimizations are also an important part of effective data acquisition systems. An optimized DBMS for OPC solutions not only simplifies real-time data collection, but also automates the conversion of historical data into various formats and human-readable forms, working as a bridge between field data and stored databases or spreadsheets. As an active remote client converts and uploads data logs to the central database, an optimized data acquisition DBMS will automatically collate tags from individual RTUs and other remote I/O devices into a database or spreadsheet, giving users the opportunity to retrieve data not only in its raw form, but also as prepared reports. Finally, with push communications, active tagging, and suitable database optimizations, an RTU should, following a network failure, automatically transmit data that was collected while the network was offline.

Cellular Technology Makes Advanced Remote Monitoring Systems Possible

With the advent of cellular communications, remote monitoring systems are changing. Simply put, thanks to cellular IP technology remote monitoring systems can now do much more than ever before while reducing system complexity by eliminating data acquisition layers, and this in turn translates into lower management and maintenance costs. By using Moxa's next generation cellular-capable RTUs with C/C++ and IEC 61131-3 programming support, our tailored software development kit, DA-Center database software, and Active OPC server, it is possible to rapidly and effectively roll out remote, low-cost, real-time data acquisition solutions with the strongest protections for data integrity, all with full cellular communications capability.

For more information, visit Moxa's website at http://www.moxa.com/Remote_Automation/Index.aspx

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