Bringing It All Together – Hybrid Wireless Systems Can Be Leveraged to Your Advantage

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Companies with large geographically dispersed networks, such as those in the oil and gas industry, can select one technology, one source, one vendor, to collect, retrieve and report data, and to assess the health of the network. Sometimes, this type of approach makes sense. Other times integrating various types of technologies can offer significant benefits that are easily and cost-effectively incorporated into one cohesive network.

The days of building large, single technology networks are likely behind us. Data and security demands at various levels of a large network are changing the game. There are options that allow us to consider better manageability, expandability, cost and speed.

Hybrid networks can include landline phone, satellite, licensed radio, spread spectrum radio or cell phone-based technologies. Data security, network speeds, infrastructure costs and on-going costs are all important factors in choosing the right technology fit to meet these objectives.

If you are collecting data from multiple locations and delivering it to offices over a widespread area, no one technology will be able to accomplish your objectives. However, by combining technologies, you can create seamless data streams from several locations and share data over a LAN or WAN with multiple users. The end result is more effective and efficient management of the network and increased reliability through reduced downtime – all at a much more affordable price.

With the many new telemetry technologies available today, it is common to have 100 percent communication to all field locations often combining several different types of technologies in one hybrid system.

System Overview

Planning a network is the critical first step, To paraphrase Shakespeare, “an ounce of planning is worth a pound of cure.” Start by asking yourself questions like these:

1. What are our goals?
2. What are our limitations?
3. What technology do we have in place today?
4. Are we willing to do a wholesale change or do we want to maintain what we have, yet optimize it?
5. Who will need access to the data collected?
6. Who will be responsible for maintaining the system?
7. What system components are available and how do we chose the best fit?
8. Do we want to have mobile connectivity
9. How will International regulations effect this plan

Let’s explore these questions a little more deeply.

What are our goals?

It is important to start with the end goal in sight. To determine that, ask yourself these questions:

- How often do we need to poll the field?
- Will we have alarms?
- Will there be more than one Controller, PLC or EFM manufacturer’s devices I need to talk to?
- What readings do we need to see (How big is each poll)?
- Can one driver support all of the protocols I need to talk to?

Although it may sound complicated, it is not. Some simple rules can help guide our answers.

How often do I need to poll? Again, what are we trying to accomplish? If we need gas measurement, we can poll a few times a day. The EFM (Electronic Flow Measurement) device will log hourly data on flow rate, pressure, temperature, etc.,and we can poll to interrogate the EFM every four to six hours and bring back all the stored data at one time. If we are working on optimization (e.g. Plunger Lift) and need more granular data, we can again use the EFM to do the local control and archive the data, or we can speed up the polling cycle in one of several ways depending on the need.

First, we must know how much data we are moving. If the stored plunger lift data and the gas custody transfer data comes to a total of 2,000 bytes of data and the EFM talks to the radio at a port speed of 19200 bps (bits per second), How long will it take to poll a single EFM? Let's assume your request for data from the host is 200 bites. This will take the host .08 seconds to load the request for data into the radio. It take the master radio .2 seconds to send the request to the slave over the air (assumes that the over the air speed is 115.2 kbps). It will take .08 seconds to load the data from the slave radio into the EFM. The EFM will need a couple seconds to process the signal (assume 3 seconds). It will take.83 seconds for the EFM to load the data into the slave. Again, it will take .2 seconds for the over-the-air portion of the transmission to get back to the master radio. It will take .83 seconds to unload the data from the master radio to the host computer. In total, we have about 5.22 seconds per EFM to retrieve the data as shown .

Chart #1

Data request function	Seconds
Host makes request	0.08
Over the air	0.20
Slave gives request to EFM	0.08
EFM processes request	3.00
EFM responds to Slave @19.200	0.83
Over the air	0.20
Master Radio gives Data to Host	0.83
Total Time	5.22

Today's newer, license free digital radios can talk over the air at anywhere from 115 Kbps to 1 megabit. The great thing about having a radio that talks so much faster than the port speed of the EFM is that you have a lot of open air time while the data is loaded from the EFM to the radio. This offers you such benefits as the ability to do real time alarms in the middle of a polling cycle.

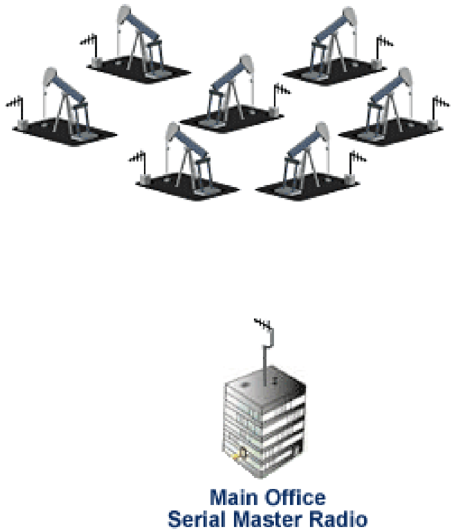


Figure # 1

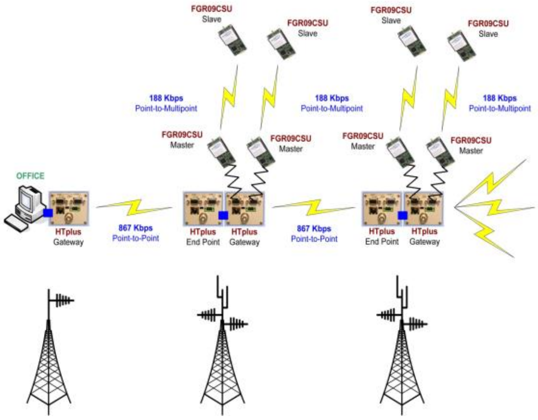
The physical capability of the EFM to load the radio will likely be a limiting factor in how long it takes to poll the field. There are ways to speed up the system polling times.

Imagine the same scenario as above with 500 wells. The requirement is to poll each well every 30 minutes. The simple math says it can't be done: 5.22 seconds to poll each well multiplied by 500 wells is 45 minutes to get a "Round Robin Poll" (once around the field). By using today's higher speed Ethernet technology in conjunction with serial radios we can create a hybrid solution. This allows us to sub-divide the field and do multiple polls simultaneously. Since the Ethernet protocol allows you to have multiple conversations at the same time, you can send multiple data requests to the field. Each Ethernet radio has an IP address and therefore will only answer when that IP address is called. Many of the newer Ethernet radios have built-in terminal servers so even if your EFM's are not Ethernet compatible, the radio acts as a protocol translator and bridges the communication barrier between serial and Ethernet.

Where legacy systems exist, a common way to accomplish high polling speeds is to replace the repeater infrastructure with Ethernet radios. Plug your serial radio masters into the ports (most of the commonly used Ethernet radios have two serial ports) on the Ethernet repeater infrastructure radios and poll the serial EFM's in the field. (See Figure #2).

By replacing the serial master and two serial repeaters we have reduced polling time by a factor of four. If we redo our math, we see that we now can poll all 500 wells in just 11 minutes.

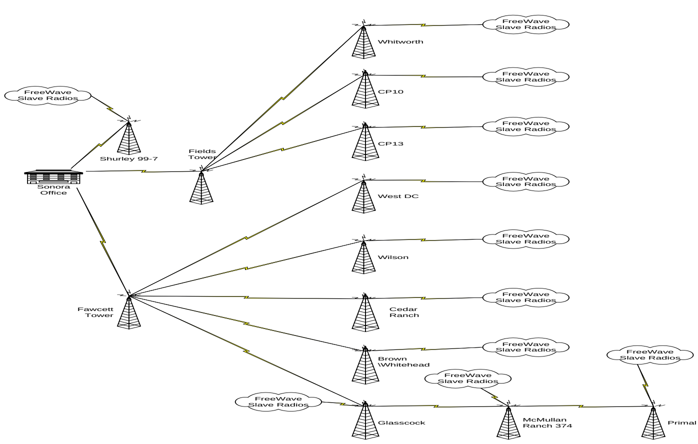
Figure # 2



It is possible to achieve even greater time-savings by utilizing more Ethernet repeaters and more serial masters. For instance, it used to take a user who has 800 wells over an hour to poll the field. Now, since installing the Ethernet backbone with multiple serial masters, the user can poll that same field in just five minutes.

The Ethernet backbone in the above case has a baud rate of 867 Kbps, and their spread spectrum radios talk over the air at 115.2 Kbps. Therefore, it is theoretically possible to have eight conversations at once.

Figure # 3



That scenario works if all of the EFM's are of the same type. What happens when half the field EFM's are from one manufacturer and the other half is from a different manufacturer?

Again, the beauty of Ethernet is that it is protocol transparent as long as your SCADA software (polling host) supports multiple protocols. Most of the newer software packages do so by having specialized drivers to support multiple protocols. The radios do not care what language the host has which allows the various EFM protocols to all participate in the same radio network seamlessly. The radio just acts like the Pony Express delivering the mail (i.e. data)regardless of the language it was written in whether in English, in Spanish or whatever language (i.e. protocol). The messages all go into the same pouch and get to the right destinations. The IP addresses and port addresses sort out the messages back at the host so the right data gets to the right recipient.

For example, as Figure #2 illustrates, if all of the EFM's made by brand A are connected to port one on the Ethernet radio, they will have the correct address. And all the EFM's made by brand B are connected to port #2 they also will be routed to the proper destination.

Who needs access to the data?
If the answer is only one office, the system can be fairly simple. Any Ethernet or serial solution can retrieve the data and deliver it back to the host. In today's complex data intensive world, more often than not, the data needs to be distributed to multiple offices and multiple individuals within each of those offices. The only effective way to do this is by utilizing a WAN. If the offices are connected by a WAN or VPN connection everyone with network privileges can access the master radio through the WAN or VPN and therefore have access to the EFM network. Again, through Ethernet, the ability to have multiple conversations at the same time expands our possible solutions.

Just as we can have multiple end devices (EFM's) respond at the same time by using an IP address, we can have multiple "masters" polling at the same time using their IP addresses. Today’s Ethernet radios and most of the newer spread spectrum radios used digitally packetized protocols. In wireless Ethernet each packet is wrapped with an IP addressing layer or IP wrapper, with the address of the recipient. Thus, conversations are guaranteed to reach the proper destination and responses are routed back to the originator.

To this point we have limited our discussion to fixed assets that are always communicating from a known position and from the same position every time. How can we plan for our work force to have mobile access to this system? Ideally this would mean that anyone in their pick up truck could have the same rights and privileges they enjoy when they are in the office and connected to the LAN through their docking station. Mobile access will require an Ethernet radio to be installed in the truck with a 12 volt DC power supply; this can be accomplished with a simple cigarette lighter type power source and an external antenna on the roof of the truck. In mobile access the first question is how much “Bandwidth” is needed? The question maybe best answered by how many people will need this access at anyone time.

Typically, bandwidth is divided equally between users, so if you have one Megabit of bandwidth and four users, everyone has access to 250Kbps. The typical problem is as the mobile access becomes a bigger part of the culture the more it is used and the higher the demand for bandwidth. Many mobile users want internet access to download documents and diagrams which can require a lot of connection time and may be graphic intensive with product information. For most wireless networks the collection of data from the remote assets back to the office is the first priority, and the mobile access is a secondary priority. Many users consider the data collection important enough to maintain two separate systems one for Data collection and one for remote access. If you plan to have both SCADA data and mobile access on the same network it may be advisable to have a backbone radio system capable of 10 to 50 Megabits per second. (See figure # 4)

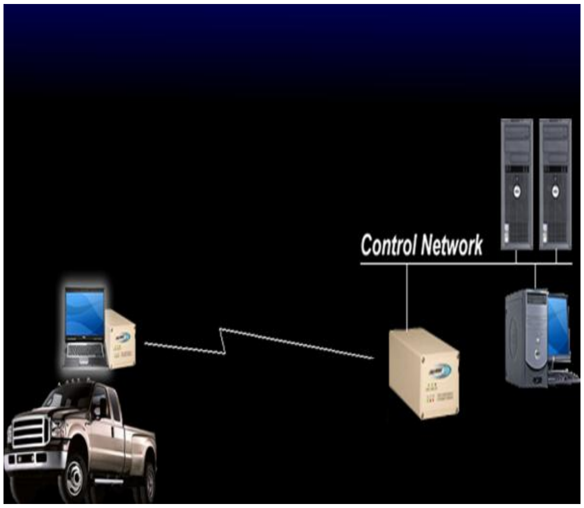


Figure # 4

Building wireless communication systems in foreign countries adds a layer of complexity to our preplanning strategy. Now the first question is what frequencies are legal to utilize in this country? In the US we have the FCC as the governing body for all wireless communication and the rules for frequency allocation are widely known and straight forward. In the US, Canada and Mexico we have a cooperative agreement that allows the use of the same frequencies in all three countries (See Figure #5)

Frequency	FCC License Required
225 Megahertz	Yes
455 Megahertz	Yes
700 Megahertz	Yes
900 Megahertz	Yes
902 to 928 Megahertz	No
1.4 Gigahertz	Yes
2.4 Gigahertz	No
5.8 Gigahertz	No

Figure # 5

As we venture in other countries, the rules change dramatically. Every country has its equivalent of the FCC, but each has its own unique rules and regulations. In some countries the 900 Megahertz band is legal to use but the output power of the radio is restricted to a small portion of what is legal in the US thus reducing the range and effectiveness of products operating in this frequency. In other countries it is illegal to use this band as it is reserved for military use only. Whenever involved in doing a communication system in a foreign country always work with radio manufacturers or integrators who are familiar with the local laws and regulations. Once you know what the rules and regulations of the area are, you can start developing a system based on the frequencies that are permitted. In this case, a path study becomes even more important than in designing a system in the US. There are two reasons for this statement. First, trying to go back and do repairs when things don’t work is much more expensive and skilled help may be harder to find so having a “fool proof” plan before you start can greatly reduce the installation cost. Second, the different frequencies will have different characteristics such as range, ability to penetrate trees and other obstacles, and general propagation over the hills and valleys. A path study will take these frequency characteristics into account and help you design a system within the products limitations.

Summary

Combining technologies is becoming more common. Many users today are using Ethernet backbones (repeater networks) to leverage combining different technologies. Some users may use the dual port Ethernet radios to bring both gas flow and pump off control back to one host through the use of a single radio system. Others may have older serial radio technologies and are slowly migrating to the new, faster, more secure digital technologies or Ethernet to the well head. In either case, by combining these technologies with one Ethernet backbone, they can prolong the use of their existing system while creating a migration path for the future.

There are other hybrid solutions that we have not discussed in this article though many users consider them to be viable depending on the system requirements and objectives. Some networks , for example, may consist of combining radio and satellite communications. Many oil and gas companies in remote and rugged terrain will install radio to a group of wells and use satellite as the back haul (instead of using an Ethernet backhaul of the type discussed in the article). This hybrid solution allows them to reduce their monthly operating cost by polling multiple wells through one satellite that has an “all you can eat” monthly bill rather than having satellite charges of $100 per month. This might be too high for a one-well solution, but if that charge can be spread over 10 wells it becomes insignificant.

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