Many SCADA (Supervisory Control and Data Acquisition) managers are looking into converting their telemetry systems from serial communication (RS-232, or RS-485) to Ethernet. Many IT (Information Technology) supervisors are comfortable with Ethernet but have not had much experience with wireless. The world of Wireless Ethernet is new enough that there still exists a lot of Myths and Legends. Sorting through this maze of misinformation can be daunting, even unnerving. The following is a list of questions that are commonly asked and seem to be the most mystifying for the average SCADA, IT person, or instrumentation technician.

So what are these mysteries?

- How do I integrate Ethernet into my serial network?
- Can I get IP addressability to the wellhead?
- What advantages can I expect?
- What does it cost?
- Can I have mobile internet connectivity for my vehicles?
- Can I speed up my polling times (How Much)?``
- Can I have multiple sites polling the network?
- Can I talk to legacy serial devices?
- Can I bring Modbus data through my Ethernet network?
- Can I talk to Instrumentation over Ethernet?
- What Frequency Ethernet Back Bone should I use?
- How do I plan an Ethernet Backbone (What are the considerations)?
- How many repeaters can I use?
- Who can design, install, and deploy this for me?
- Is it secure (Encryption, Authentication)?
- Is it reliable?

The trend in data communication is clearly moving to Ethernet, the advantages are too compelling to ignore. Security, faster polling times, mobile communications. Internet accessibility and IP addressability all provide benefits previously unavailable with serial communications.

So who will care about the answers?

Radio manufacturers are building an increasing number and variety of wireless Ethernet radios. RTU, PLC and EFM manufacturers are including Ethernet ports on all of their latest generation devices. The transition has begun, but the process of matching the right products to the right applications is still early in the learning curve. Let us take these questions one by one and try to examine each of them.

**How do I integrate Ethernet into an existing serial network?**

With millions of dollars invested in legacy serial systems this is one of the most common questions. Many radio manufacturers building terminal servers (Protocol translators) into their Ethernet products, if needed an external terminal server can also be used to convert serial data to Ethernet. The entire system does not have to be replaced to gain the benefits of Ethernet the end user can start by changing the Master radio and the repeaters sites to Ethernet and leave the slave sites as serial and still gain many of the benefits.

See Diagrams #1 & #2
Diagram #1 and #2 are the same system, Diagram #1 is a graphic representation of changing the Master and repeaters to a high throughput Ethernet system, while drawing #2 is a block diagram of the same system.

By using the High Throughput Ethernet radios as a “Backbone” between repeaters we gain IP addressability for all data traveling through the network. We also have port identification (Port Numbers) that route the data to not only the correct IP address but also the proper port number. If our data were mail being delivered by the post office the IP address would be the equivalent of the regional Past Office, and the Port number would be the mailbox with in the post office. Now that we have multiple ports on every IP address we can start to split the system in multiple systems. (See Diagram #3)

Each Ethernet radio can now have 2 serial Master radios connected to its 2 serial ports. Each master has its own group of slaves or in other words its own network. By adding 3 High Throughput Ethernet radios at 3 repeater sites, to an existing network of 600 radios we could split the network into 6 separate networks of 100 radios each. Thus dividing polling times by 6. If the polling time was 120 minutes in the old serial system it would now be 20 minutes in the new Ethernet system. This represents a huge technical advantage for a relatively small capital expenditure (About $6,000.00).

Can I get IP addressability to the wellhead?

The way to get IP addressability to the wellhead is to install Ethernet radios at each well. The RTU or EFM at the well head does not necessarily need to have an Ethernet port nor does it need to have an IP address. The radio can convert the Ethernet traffic to Serial and vice-a versa. The radio can be a simple wire replacement device if your wellhead equipment has IP addressability, or it can act as the protocol translator between serial devices and Ethernet networks. If you have older licensed radio technology that you are using the same is true, we just move the master radio for the licensed system to the repeater and tie the system (Tail-end) into the Ethernet network.

What Advantages can I expect?

The most common advantages managers are looking for are speed, which translates to faster polling times. Real time alarms, mobile connectivity (Access to the network from the truck) connectivity to devices that have serial connections but do not have Ethernet connection, security, encryption, access to data from multiple offices, & peer to peer communication.

What does it cost?

While this is an open ended question there are many high throughput radios that deliver approximately 1 megabit over the air throughput that
sell for $1,000.00 on each end. As a general rule the higher the throughput the more expensive the solution. The most important thing to remember is the associated cost of installing a system. Many of the highest throughput devices assume that there is AC power available everywhere a radio is installed. One end user recently told me that he had paid $20,000.00 for solar panels and batteries for a high throughput repeater site; this did not include the cost of the radios, the antennas, or the coax cables. Obviously he had the wrong tool for this application, because other products could have done the same thing $500.00 worth of Solar, and batteries. End User should look closely at power consumption needs of the products they are considering, as well as range, and throughput, to insure they are selecting a product that will meet all of their requirements.

Can I have mobile Internet connectivity for my vehicles?

While the short answer is YES, the more in-depth answer is Yes but not everywhere. Just as we have all been in places where our cell phones did not have a signal radios are also subject to the same laws of physics. Radios rely on "Line-of-Sight" to communicate; there will be areas in every application where the person in a vehicle will not be within line of sight of a repeater tower. Sometimes a technician will have to drive to a hill top, or open area, nearby to get line of sight back to a repeater.

Can I speed up my polling times and if so by how much?

The short answer here is also YES, but the how much answer is a function of two variables. First let’s look at one of the advantages of Ethernet, and IP addressability. In a serial system there is only one conversation allowed at a time, much like a telephone call, the Master has to hang up from calling one slave before it can call the next. In Ethernet the rules change, we can call multiple slaves at the same time. The IP addresses of these multiple slaves allow the master to route the conversation to the right slave, and then to receive multiple messages back at the same time and to de-scramble the messages by using the IP address. Again it is like the mailman looking at the address and putting only the right mail in the right mail box. (see diagram #3)

Diagram #3

So the question now becomes if you have a "Hybrid" serial and Ethernet system, how many serial networks you can break your system into? By moving the masters to the repeater sites we have already seen that we can create 2 masters at each repeater site. Or if you have an all Ethernet system the question becomes how many conversations
will your host software (Polling Engine) support at one time. It is common to see polling times reduced by 6 or even eight times in “Hybrid” systems.

Can I have multiple sites polling the network?

YES the IP addressing ability of Ethernet allows conversations to be routed from one point to another point within the network. The best example of this is at the office multiple work stations can poll the server for information at the same time. The server knows which station made which request by the IP address of the station, and sends the right response to each. In the case of a IP based radio network, the regional office (say it is in Tulsa OK) can poll the field, and the corporate office (In Houston TX) has the same privileges once the system has IP addressability.

Can I talk to legacy serial devices?

As we discussed earlier this can be done in two ways. Either with Ethernet radios at the well head or by combining Ethernet and serial in a “Hybrid” System.

Can I bring Modbus data through a Ethernet system?

Yes, the radio system is just the messenger in most cases the radio acts like a replacement for wire and transmits the message from the slave to the host. In the case of Modbus the radio is packetizing the message and putting it in an Ethernet wrapper for transmission. At the master site the packet and Ethernet wrapper are removed and the data in its original format is handed to the Host. Many radios have a Modbus feature that allows the radio to “Spoof” the Modbus device into waiting a little longer than normal before it breaks its link. This allows the Host and the Modbus device to have a two way communication (Also know as Full Duplex communication, Modbus was only designed for one way communication originally).

Can I talk to instrumentation on an Ethernet system?

YES many instruments have RS-232 or RS-485 communications but do not have a unique device ID; the Ethernet radio can take the place of the device ID by using its IP address. In this way the host can communicate to Level Sensors, Chromatographs, Provers and correctors, etc. Additionally with many of the new wireless I/O radios that are now available it is possible to communicate directly from the host to an Analog device in the field. An example of this is a pipeline company with offices in Tulsa that recently polled a pressure transducer over the internet that was located in McAllen Texas. The communication went over the web and the radio system without any RTU’s or PLC’s in the link.
What **Frequency Backbone should I use?**

The best technical answer to this may not always be the best practical answer. Most radio manufacturers have Ethernet radios in 900 megahertz, 2.4 Gigahertz, and some have 5.8 Gigahertz available also.

The lower the frequency of the radio the more forgiving the radio is for line of sight issues such as; penetration of trees, buildings ect. But the lower the frequency typically the more congested the spectrum is. Most data communications in this country is in the 900 Megahertz band. Therefore it is normally better to have the “High-speed backbone” in a different frequency band than the SCADA, or Gas measurement systems. It is always advisable to get an RF (Radio Frequency) expert to take a Spectrum Analyzer tool to the area where you purpose to install a High Speed backbone and get his feedback on what will best work in this environment.

**How do I plan a Backbone, what are the considerations?**

The first consideration is towers and line of sight. I group these together because you need to insure that the towers have line of sight to each other and to the locations where your slaves are located. The first step with towers is to determine if you are going to purchase or produce. The purchase option is often the quickest, and that is to identify commercial towers in the geographic area you are interested in and contact the owners for lease space on the towers. Typically rent is at least $1.00 per foot per month, so if you rent space at 100 feet it would cost at least $100.00 per month. The produce option is to identify high ground where you can erect a tower of your own. Prices vary but a 100 foot tower will cost about $10,000.00 in most areas. Once you have identified the sites you want to use, a path study should be done to determine if you can communicate to all of your proposed towers. All you need for a path study is the GPS coordinates of the proposed towers and the heights where your antenna will be installed. Many communications companies that act as resellers for radio manufacturers will provide all of these services for you as a part of a turn-key service along with the purchase of the radio equipment.

**How many repeaters can I use?**

The answer may vary depending on the manufacturer you are using, but many manufacturers have no limit to the number of repeaters you can use. It is important to have a qualified technician design the system because one of the most common problems in radio systems is poor design where two repeaters are interfering with each other.

**Who can design, and install this for me?**

This maybe the hardest question of all to answer. In most cases the companies that design and install radios are aligned with specific manufacturers. They only sell one brand of radio. Often the best choice
is to discuss products and applications with a manufacturer and pick the products you want, then get the manufacturer to recommend factory trained and certified resellers in your area.

**Is it Secure?**

Not all radios are created equally, be sure you look for security when picking a product. The commonly accepted security features to look for are:

- 128 bit AES encryption
- RADIUS Authentication
- MAC filtering
- Dynamic Key substitution
- VLAN Tagging

If the product you use has all of these features you should never have any concerns about security.

**Is it reliable?**

Perhaps the answer is “Compared to What” everything can fail, but a wireless Ethernet system that is properly designed, and properly installed, should be 99% reliable. There will be “Acts of God” such as lightening, flood, hurricanes, etc that can effect a radio system, but if you ask your potential supplier for return rates on the products you are looking to purchase they should have a less than 1% return rate from all causes.

**Summary**

The advantages of Wireless Ethernet are two inciting to ignore. Many speculate that Serial communications will go the way of the black & White TV. We are seeing the way the Data world communicates change. It is early in the adoption phase, but Ethernet is quickly becoming the standard for many Oil & Gas producers.

When looking to implement your first system asking all the right questions is a great place to start. Wading through the misty moors of myth & legend about new products is an unpleasant and tedious job. But all change has some risk and some pain associated with it. The change will only happen when the pain of remaining the same is greater than the pain of change.