ADVANCE COMMUNICATION DESIGNS

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We say **Advanced** Wireless Data Radio Communication Systems Design Process not because this is a more in-depth and more technical process, but because the systems involved are complex in nature and must be carefully **designed** and programmed. If anything, what I want to do is teach you a more simplified approach and technique to design a SCADA or Telemetry project, but one which you do the same whether the system is large or small.

By ***design,*** I mean we take this specified approach, or ***Process***, which is consistent every time to show us geographically where the sites are and what the terrain challenges are for each site. We think more about one site at a time than the whole forest of sites. We need to ***visit the area*** and ***know*** the foliage conditions, man made structures and any other issue that may inhibit a good communication **"path".** What is a path? I am sure you most likely know this, but a path is the line of site from the end device back to a collection point, whether a master receiver or a repeater or repeaters between each end point and the master collection point. There must be as clear of a straight line path as possible between key points of collection or repeating or no data is consistently transmitted in those com systems which **are line of sites technologies**.

In the last 10 years the needs and requests of the IT departments in oil and gas companies to have real time data for marketing decisions alone as increased the challenges for those designing Telemetry and SCADA systems. To get the amount of K data back to the offices, many of them in a different state, has meant the end devices and the data radios connected to transmit data have had to have increase capabilities in the amount of throughput data rates and packet sizes. The buffers have had to have increased memory. Because of this, the industry has gone to faster radios that could be designed more immune to RF interference. Therefore the use of 900 MHz systems, both Licensed and unlicensed Spread Spectrum systems have become the technique of choice. Ethernet based com radios are being used as well. The two frequency bands have been the 900 MHz as mentioned as well as 2.4 GHz. **Both are line of site communication systems.**

Line of site wireless communication means everything has to be "right". By right I mean, the path, or line of site to the slave or end device site has to be good enough for a consistent transmission strength to achieve the over the throughputs required for a quality system. Knowing how to get multiple sites in a varied terrain area all back to a central collection point creates the need for the consistent process mentioned. The process directs the understanding of the challenge and helps make the challenges workable. Before getting involved in the actual design, a need for a complete understanding of the goals and the manner in which the goals will be achieved must take place.

A part of the decision making process when selecting the specific wireless communication devices for a project should be a complete understanding of all the challenges and needs of the project understand the requirements needed from the communication devices available to select from. A part of the process that must be completed in advanced systems (multiple sites in varied terrain) is a TELEMETRY QUESTIONNAIRE (See Appendix). Please review the Questionnaire and you will see if all questions are understood and written into the goals and design processes, all the bases that need to be covered, will be covered.

Possibly the most important issue to understand and outline is the number of times per day you will request data to be received and the amount of data to be acquired per these times. These are called poll times and poll data size. If you want to poll only once a day and only get a status report that takes only a few kilobits of data, many options are open. This would include systems that only receive a data response if there are issues to deal with such as high or low levels, open or shut valves, etc. These are called status changes. Devices are available to do this such as the CDPD modems as well as the Burst Technology and Cellemetry devices which operate on very low power and send only very small packets of data. The value of these are in the simplicity of installation and use. The backbone is taken care of by the cellular carriers. Where available, the build out is such that getting on a system is not an issue. Wherever your cell phone works, you normally can use the overhead part of the system for the Burst, Cellemetry or CDPD systems.

Even when deciding to use these simple systems, having a thorough knowledge of where each site in your system is located is of vital importance for many reasons. Now, when the project's data requirements require a wireless data system capable of being polled from once a day to every few minutes with data sizes from 100 kilobits to a couple of megs, obviously more care should be taken in selecting the data hardware device. Again, before making those decisions, understanding the needs and requirements by completing the Telemetry Question are is

most important if not absolutely necessary. You cannot design advanced systems before knowing where you want to end up with the data and how you are going to get there. Just like the importance of a good foundation when building any structure, you must begin to consider the design and installation of a wireless data communication system as designing a structure which also has to have a good foundation.

Just as you must have good blueprints to complete any structure, you must have a blueprint of your wireless data communications systems before you start. It is best to begin with the front end. How is the data going to be brought in to a PC? Where is the PC going to be located that is considered the Master Polling PC? Is the Master Polling PC going to connect straight to the Master Polling Data Radio Modem or will it remotely connect to the Master Polling Data Radio Modem by the use of a dedicated telephone line, satellite, Ethernet Serial Converter Server? Will the data be shared with other offices, whether at that location or cities or states away?

Besides the known telephone lines, satellite and CDPD, Serial to Ethernet Servers are now available that can interface between the Master Polling Radio Modem many miles, cites or states away and allow for TCIP (Telnet) connectivity to the Master Radio Modem. You can then get the data back over the company network or TCIP into the Master Radio Modem which then polls all the remote radios and sends the data back through the network to be shared by anyone with the right access.

We now have made the decision on how we are going to get the data and view that data at some master site or shared over many. What is next?
The remote system must be designed to best maximize resources and for the most efficient and consistant manner in which to poll the data. How do we do this?

We must know the exact physical location of each site. Using portable GPS devices that can be purchased anywhere is the most common method. You simply go out to each site and write down the coordinates in Latitudes and Longitudes. From now on, we will call this the Lats and Longs.

Having the lats and longs is just the first step. What do you do with them? This is where the **Remote System Design Process Begins**. Here is the outline you will use to go from basic raw data to a completed system design. To professionally complete a system design, you need two basic software packages. You first need a simple Mapping Software and then a Propagation or Path Study Software Package. The **Mapping Software** is about **$70.00.** The **Path Study** software is from **$1,500.00 to $8,000.00. HERE IS THE PROCESS!**

WIRELESS DATA RADIO SYSTEM DESIGN PROCESS

1. Acquire the lats and longs on a Excel sheet. A latitude will begin with the smaller of the two numbers. **Example 31 34 45.6. This is a Latitude. 99 45 23.6. This is a Longitude**. Latitude is north and south on a map (up or down) while Longitudes are east and west (right to left, left to right). In North American, the farther north you go the higher the latitude number. North Dakota has a latitude of 48 degrees …..., while south Texas may be 26 degrees…… . The farther west you go, the higher the longitude number. Western California is 116 degrees to 124 degrees while Maine is 67 degrees…. . You must understand Lats and Longs to design wireless data systems.

2. Use the notepad option found in the accessories of any windows program to transpose the lats and longs into a format that will be used to later Import the lats and longs

```
N35 43 51.5,W99 14 6.3,BAKER COMP STAT
N35 38 11.0,W99 12 35.9,CUSTER COMP
N35 40 28.8,W99 31 1.3,MERRICK COMP STAT
N35 46.80,W99 34.99,ROLL REPEATER
N35.74776.W99.21572.OFFICE
```

into a mapping software. Here is the example. Let's say that you acquired the lats and longs with your GPS and they look like this: 35 43 51.5 N 99 14 6.3w To type this into the format that the Delorme Mapping Software can import to the map you do type the lats and longs like this, paying careful attention to where the commas, spaces, etc. go. If it is done like this, you cannot Import the Notepad lats and longs into the map. N35 43 51.5,W99 14 6.3,SITE NAME. Whatever format you used on your GPS to get the lats and longs is okay as long as you get the spaces and commas correct and use the N and W where they are located on this example.

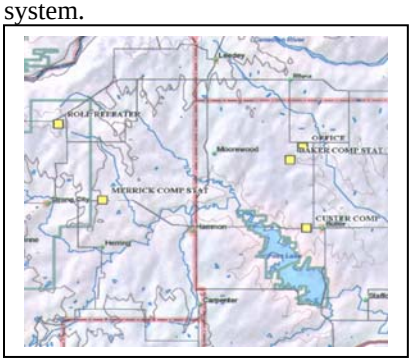
EXAMPLE 2. You acquired the lats and longs in degree decimal. 32 16.27 102 09.22. Still type just as you took the coordinates into Notepad like this: N32 16.27,W102 09.22, SITE NAME. Again, make sure the N and W are in place correctly and use commas per the example. Nothing else will work correctly.

3. Before begging the design**, first,** on a **separate notepad**, list the lats and longs of known or available repeater sites that may be used to aid in the design process.

4. Open the mapping software. I use **Delorme Topo USA.** You can purchase this at any chain electronics businesses like BestBuy, Office Depot ,Circuit City, etc., for about $70.00.

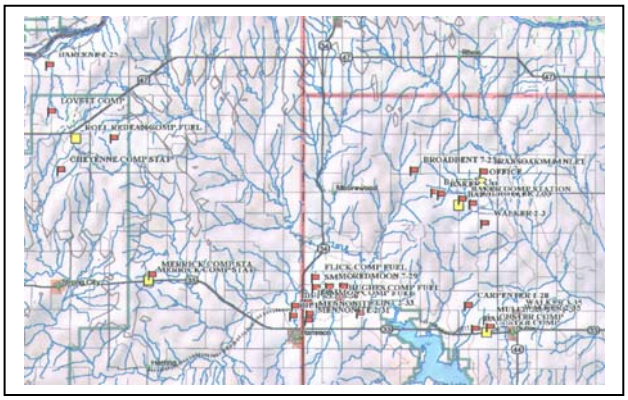
5. Select the state for the project from the discs available and open. Use the directions to go to the geo area in the state opened where your sites are located and zoom in.

6. Go to the Draw Option and click on the Flag. This brings up a menu to use that will allow you to select an icon. Use the Yellow Box for Repeater Sites, Towers, the Master Site, etc. These are the foundation sites for the system.



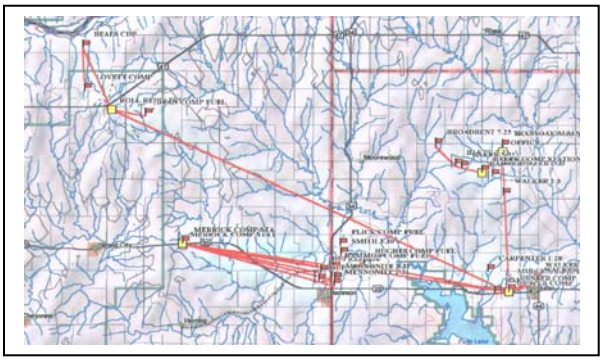
Left: The yellow boxes are repeater sites and the master radio.

7. Go back to the Draw Menu and click again on the Flag and select the red flag icon. These will be the remote slave sites you will link to the Master or through the Repeater sites to the Master.



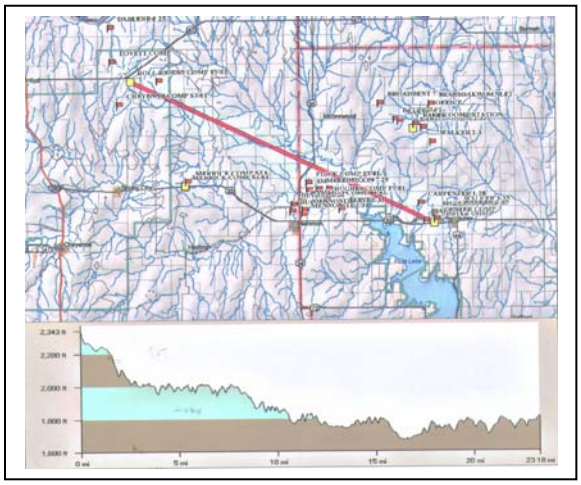
Above: By importing the Notepad list of Slave Sites, the Slave sites (red flags) are no visible with the Repeater Sites in Yellow.

8. Go back to the Draw Menu item and click on the \ line icon and highlight this. You are now ready to start trying to Link the Sites back to the Master Site. Start with those sites close to the Master and work your way out. You first left click on the Master and let the mouse button go. You then drag the line from the Master to the Slave Site until you see a small highlight on the bottom of the slave site (bottom of red flag).



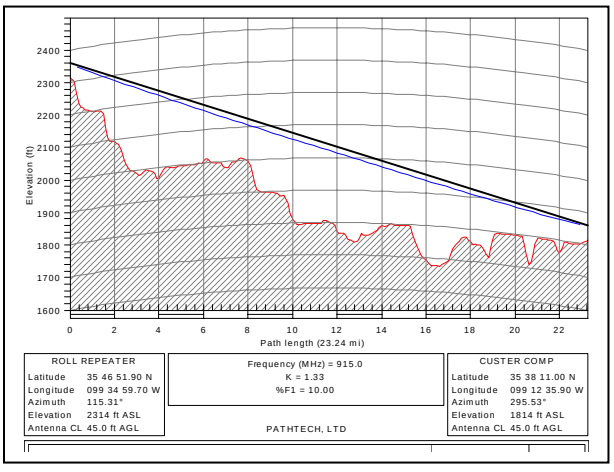
Above: All the sites have been linked back to the master through repeaters which were linked first to the master site.

9. You can now view the terrain between the two sites for a general idea of what the link might look like, or the general feasibility of the link. Once you feel the link is feasible, you are ready to do a professional path study with the use of the path study software. I use PathLoss. There are several affordable ones on the market. Micropath is another easy to use and affordable package. You can review both or more on the internet using a search for radio propagation software, path study software, path analysis, etc.



Above: The Delorme allows to get a preliminary view of how the path might look.

10. Follow the directions on data insertion into the Path Study Software and complete a link study between the Master and Slave icons on your mapping software (Delorme). If you have a good path using the professional software, you have a link. You will complete this process over and over again until you have a link between each slave site to the master or through the repeater or repeaters on the system. Many times it takes going through multiple repeaters to get from the last slave site to the master.



Above: A path study using professional software, confirms if a good path exists and also indicates how to point the antenna correctly. This is the Azimuth.

11. Once you have completed Path Studies on all sites in the project, that has all links joined and linked in some way back to the master. Your project is now ready for a System Architecture Drawing.

12. A System Architecture Drawing begins with a box at the top of a page that represents the Master PC. Remember this may or may not be the site of where the master radio is located. If this represents the company Network site where a Master PC is located that will remotely poll the Slave through a Master remotely located from the Master PC, then the first box is the Master Polling PC and a description of the connectivity between this site and the Master Polling Radio Modem. **(REFER TO APPENDIX A FOR THE ARCHITECTURE DRAWING).**

13. Continue to go from the Master Polling Radio Modem out to the first radio modems or repeaters linking each system change as you go. Draw arrows between the boxes to indicate how the linking system works its way out from the start to the finish of the system. All data radio products have unique capabilities that allow for store and forward, etc. These options are what allow for the more complex systems to be developed in the most efficient and cost effective manner. Spending time in research here is invaluable.

You must first understand the complexity of the system you have now designed before you can understand if the product you are going to select has all the options that will be required to bring back you data from the farthest site in the system back to where the data can be viewed. Completing the Design Process above is the only way to completely understand these needs. Either the end user or a company that specializes in data design must complete this process for the best system available to be completed.

14. Understanding how to program each remote slave site is important now. The company representative that is providing the remote communication device should now come to complete a seminar and teaching process for your field techs. I highly suggest making up a Radio Programming Template for whatever device selected. From the System Architecture page, complete a program page for each radio system change from the beginning to the end of the system. Save these pages in a binder and in a File to be used whenever needed. Use these program templates per each system radio type to be used in the system to pre-program the test radio and then all radios in the field before they are installed. There are times, when the program is completed on site. The typed program page is especially important at these times.

15. Once you have selected the radio modem hardware that has the options need to best complete your system design, pre-programming and testing the Master Polling Software and any Network Interface or Ethernet network servers needs to be done before the first remote radio is installed. This is the time to install your polling software, whether it is the Field Measurement Software of the device installed on your remote sites or special MMI packages available, now is the time to make sure you can talk to the end devices. Set up the test measurement or monitoring device you are using at the remote field sites where your field techs can install the product polling software or MMI interface software to a Master Polling PC. If any other interfaces are going to be used, hook them up to the system. Install a Master Polling Radio Modem to the Master Polling PC or to the Interface Server or other device such as satellite hardware or CDPD. Have the end device company technician set up test numbers in the end device and have your company IT person test poll the end device until you know that all set up parameters are understood. Pin outs are seriously important to know between all devices. Baud rates, protocols, and parities must match or you will not correctly poll remote sites or get the data through all the interfaces.

16. While this testing process is going on, it is the time to make sure all repeater sites will be ready for the system to be installed. If there is a need for antennas to be higher than 50 ft or so, plans need to be made to ether lease tower space or contract out for towers to be installed on the recommended repeater lat and long sites.

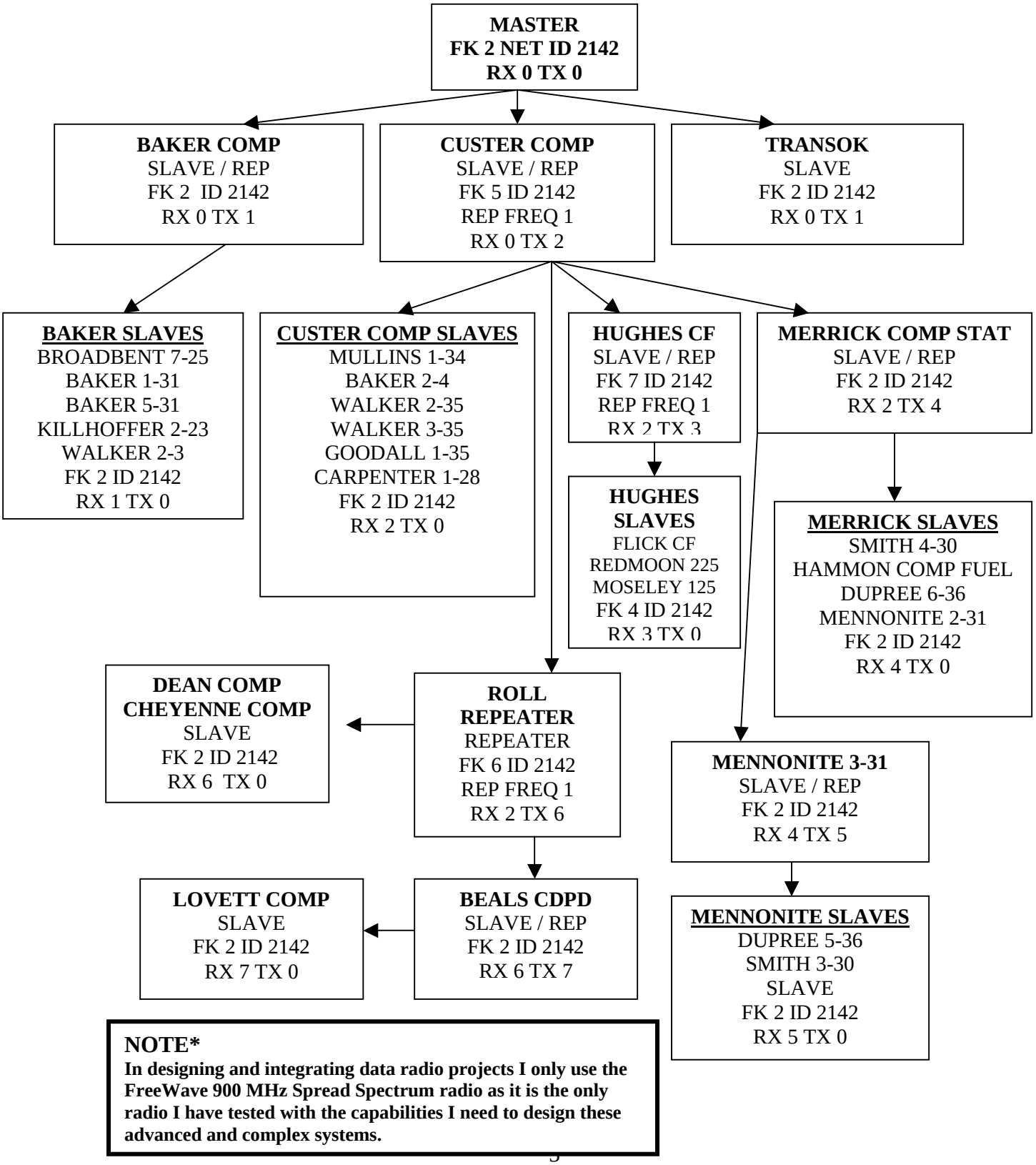
17. Now is the time to make sure what the engineering said and what is real both agree. Go to the sites and make sure before you do the final investment on those tower installations or install expensive coax and antennas on lease towers that no man made obstacles exist which the software did not see. Hidden interference issues such as high gain paging and some cell sites issues cannot be seen until you install the system, but make sure the obvious is taken care of.

18. The Repeater Site towers and any needed coax and antennas are now installed and tested. Test these with a test radio installed and the polling software which you will be using. Make sure you are getting the best “link” possible. If problems exist between some individual sites, now is the time to solve this. How do we do that?

19. All good radio modems now offer options that will help direct the path of the data through further sub-netting programming techniques. The important thing is to plan ahead and understand the needs of the project from beginning to end.

SUMMARY: The needs, requests and requirements of those using wireless data devices are what continue to drive the creation of the new options available for wireless data modems. The fact is that those who have access to the best data, have the tools needed to make timely decisions in oil and gas that translates into profits and growth.

SYSTEM ARCHITECTURE
SHOWING THE FLOW CONNECTION OF THE DATA FROM THE MASTER TO THE FINAL END DEVICE. THE DATA BACK TO THE MASTER FLOWS BACK ALONG THE LINES JUST IN REVERSE ORDER OF THE ARROWS.



NOTE*
In designing and integrating data radio projects I only use the FreeWave 900 MHz Spread Spectrum radio as it is the only radio I have tested with the capabilities I need to design these advanced and complex systems.

SCADA / TELEMETRY QUESTIONNAIRE

1. What are the project goals? Define each goal. Example: (1) To acquire data from Fisher Electronic Flow Meters. (2) To poll each site every hour. (3) To collect the data at our field office and make it available in the control room located in Tulsa, Oklahoma in real time using the company network attached to a Frame Relay Circuit where the master radio is collecting the field data.
2. Do you have a radio license we want to use? What frequency? Can it transmit at the baud rates necessary without interference so that the data is consistent? Do we want to use the license or consider either acquiring a new license or using a Spread Spectrum product?
3. How many sites do you have which we want to monitor or control?
4. Do you have a list of the coordinates, which are the geographic latitudes and longitudes of each site? These are normally acquired using a GPS.
5. If the sites cannot communicate direct back to the central collection point, then the data must be repeated. If repeaters are needed, do you have access to leased repeater tower sites or land sufficient to construct towers on. Do you need assistance in finding repeater towers or in the construction of repeater tower sites?
6. Do you have accurate field maps showing the roads to each site if installation support is needed?
7. How is each site powered, ie, AC or Solar?
8. Describe your understanding of the general terrain and any key obstacles that you know may hinder line of site communication.
9. What will the model (model number) of the brand of devices to which the data radios will be connected?
10. Does each device have an available RS232 Communication Port? RS485? Ethernet?
11. What Baud rate is each device capable of transmitting?
12. What is the Protocol and Parity of each device? IE. Example: Modbus RTU 8N1
13. Do you have a Master Polling Software at the Master Radio site or remote which will be connected to the Master by a gateway, etc? What is your software package?
14. Do you wish to remotely access the Master Radio data being collected and if so, how, and to where will it be collected from?
15. Who is going to install each remote radio site? Who will set up the Polling Software at the office? Do you want a company person trained on the installation, operation and trouble shooting of the data radio communication system?
16. Detail what type of proposal you need? Available from most system integrators are packages that include just the hardware needed for each data communication site, ie, radio, mounting hardware, data cables, RF pigtails, antenna and coax and mounting poles or packages that include turn key labor to install as well. What best fits your company and its long range needs? I do recommend working with wireless data radio systems integrator for your needs, one who will handle all the design and product needs rather than just a company that provides only a part of the needed puzzle. In this way you get total system responsibility. The only thing you should consider is for your own company technicians to install the site systems. Most or easy to do and in this way your company staff stay involved for trouble shooting needs.

PATHTECH LTD

PathTech LTD is owned and operated from Odessa, Texas, by Bob and Theresa Halford. The company was formed to meet the needs of oil and gas users requiring wireless data radio systems to be designed outside of the end user company. PathTech makes it revenue by selling system kits for each remote site of a wireless system. It earns repeat business by providing guaranteed and successful projects. Bob will work in the field five years after the installs to make sure a site is working at no charge.

PathTech only offers the FreeWave Technologies line of wireless data radios. FreeWave is based in Boulder, Co., and has been in business since 1993. Bob Halford began designing FreeWave product systems in 1998 and has been involved with the installation of approximately 14,000 radios since 1998, 10,000 of these since forming PathTech in 2001.

PathTech does not charge for the design and implementation of those designs for its customers when the radio kits are purchased from proposals completed by PathTech. PathTech has at its disposal several communication companies who specialize in tower installation and individual site completions. Therefore, PathTech can offer either the complete design and hardware kits to complete the Master, all repeaters and the remote sites where the company involved uses its field technicians, trained by PathTech at no charge, to complete the installations, or PathTech can offer turn key custom packages billed per the customers needs. The goal is to have a Process from beginning to end which stresses consistent data transmissions under many and varied terrain types and conditions.

Bob Halford