BASIC APPLICATIONS OF TELEMETERING SYSTEMS
CLASS #3050

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Telemetering, or transporting information, has been with man from the first days of recorded history, at first in primitive forms such as grunts and smoke signals; more recently [in the past hundred years] in progressively sophisticated forms including radio and satellite systems. Harnessing electricity led to the "magic" of telephony. Telegraphs, and later telephones employ a technology so fundamental as to be the cornerstone of the telemetry process.

The creation of a carrier signal is foundational to any telemetry signaling whose information is modulated [rides] upon it. Telegraphs employed a process of using current flowing through a wire as the carrier upon which a manually operated key shifted the transmitted frequency in coded fashion [intelligence]. More sophisticated systems of FSK [frequency shift keying] used electronically keyed devices.

East coast gas pipelines were among the earliest to use telemetry up and down the miles of pipeline system. The system used two "devices", a telephone line to provide the carrier and a man to voice modulate the data [information read from gauges] to people in towns with strange names like Philadelphia and Boston.

As radio systems were being developed using a transmitted signal of a single frequency, a technique known as amplitude modulation was employed. AM is a technique to which many owed a great debt of gratitude including Bing Crosby, Jack Benny and others. More recently frequency modulation upon a radio carrier [FM] has been far more popular, in part due to its greater signal to noise ratio properties within its range of frequencies.

Radio frequency bands have been organized into segments allocated by the Federal Communications Commission [FCC] for various activities. AM radio 535-1600 kilocycles per second, or Kilohertz is used for radio broadcasting by licensed stations. 50- 54 Megahertz is allocated to amateur radio operators and low band commercial users, while 54- 108 Mh. is used by television broadcasters.

These bands, with bending wavelengths, offer long-range communications capabilities which make them attractive for such uses. All of the channels on these frequencies, when use industrially, were obtained by FCC licensing. For many years it was thought that only by licensing could interference issues be held to a manageable level. Therefore, much planning and time went into getting any system on the "air". The next question that came to the forefront when radio was being designed for data use was "what frequency do we use for this?"

Each frequency band has it's own advantages and disadvantages relative to distances signals can be transmitted, susceptibility to RF interference, and attenuation by objects such as buildings, trees, barns and hills. Additionally, the elements required to reliably sustain a suitable level of effective radiated power {ERP}, and the designs of receivers with adequate sensitivity or signal to noise rejection capabilities must be considered.

Problems with each band are "seen " in the way signals behave in travel and require their own unique solutions, including those used in our industry.

Circa 1935 the most pivotal device of all modern telemetry systems was first designed. Devices that could electronically modulate and demodulate intelligence, in effect convert intelligence found in analog values to digital values and back again! Reliable, accurate and cost effective means of communicating! Even the sky is no longer the limit in a sense. Modems have become the centerpiece of all industrial communications systems, whether telephone lines, microwave, or other wireless systems are used.

Networking computers in local area or wide area configurations also utilize modems extensively and employ a widely used electrical connection standard known as RS232, or in some cases, for relatively short distances, RS485.

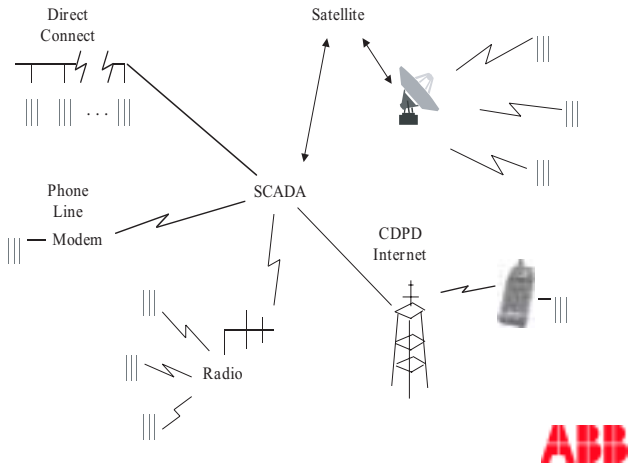
Supervisory Control and Data Acquisition systems [SCADA] systems use several communications platforms – hardwire, two-way radio, telephone, cell phone [including CDPD radios] digital wireless radios, microwave, fiber optics, and satellite.

Protocol [prearranged method of communication, or convention] must be resolved, and transmission speed [baud rate] must be agreed upon as well. Obviously the faster you can transmit [simplex] and receive [half duplex], or send and receive simultaneously [full duplex] the more you can accomplish in time. Some modems can do data file compression, and have flash memory, as opposed to the legacy read only memory [RAM] still in use. Not too many years ago when modems could ask how another modem was equipped, then adjusted itself automatically to be compatible with its conversation

partner we called them “smart modems”, and we were right to do so.

The 450 MHz band was among the first to be widely used in modern oil and gas applications, largely because of its distance of travel attributes. After this came the use of 800 MHz. Their shortcomings, however are significant. Among them are power consumption, especially at remote locations, susceptibility to R.F. interference, and timing issues relative to “request to send” and “clear to send “ handshaking and the delays they require. Additionally, the band is relatively full. If you have a license it can be useful but many repeaters cost the user recurring fees in the $10-30 dollar / month range. much like cell phone, CDPD, satellite and microwave systems.

The diagram below is intended to give the reader an overview of some system possibilities and configurations. Many systems demand the use of more than one type or mode of communications, and many hybrid systems perform quite acceptably.



SO WHAT ELSE IS AVAILABLE?

Enter 900 Mhz. This is perhaps the most interesting and practical radio band on the planet. It is interesting because of its wide spread applicability including sports [auto racing] and military [army cavalry] functions. An army may march on its stomach but it achieves its objectives with good communications. For us, however, 900 MHz. provides excellent low cost solutions to most of our telemetry problems.

There are frequencies allocated for licensed 900 Mhz. and unlicensed 900 Mhz. Spread Spectrum radio. Both can be successfully deployed. It largely depends on individual preference more than communications engineering.

Licensed 900 Mhz may be a good choice for your needs. The radios are licensed for 5-watt transmission, and while licenses are available on a somewhat limited basis, depending on your area ‘s density of existing license holders, it takes some time to procure one. The 5 watt licensed radio is capable of operating over significant distance, although it is important to remember that the higher the frequency the less “flexible “ the wavelengths behave. In the 900 Mhz. Band there is virtually no bending of the waves. It is line of sight only. This is a quality of great strength in many systems. There is some interference protection, but if it does occur there seem to be reports of difficulty in getting it resolved.

In properly designed spread spectrum systems, unlicensed 1 watt radios, where each radio can be used as a remote point, or as a repeater, another attractive element is seen. As the number of points of contact in the system increase, the more cost effective the solution becomes. Other attributes include higher baud rates, resistance to R.F. interference, full duplex capabilities, low power requirements, tiny size transceivers, low polling overhead or turn on/ turn off times and most have integrated diagnostics that are quite sophisticated.

The frequency hopping techniques of one manufacture’s spread spectrum radio are well established, providing uncommonly reliable communications especially when packet protocols are provided. Communications are secure enough to prevent enemy interception, which was the original spread spectrum design objective for the military, and rugged enough for torturous applications such a NASCAR racing and natural gas measurement in West Texas.

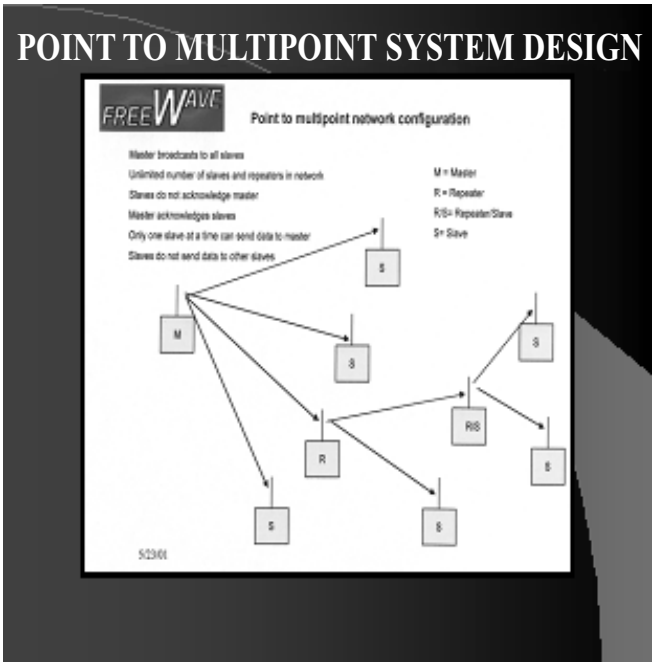
This frequency hopping feature allows, as is the case in the Powder River Basin of Wyoming, literally thousands of radios to be operated by several end users in a few square mile areas. Serious user density can be realized where repeater resources are often shared resulting in efficiencies previously unknown. One hundred percent reliability in telemetry systems was considered unattainable a few years ago, but considered nominal performance in several North American systems today. But, the kind of success seen in the Powder River basin didn’t just happened. As with any engineered system, it, by definition, requires planning and attention to detail to bring smiles to faces on “opening day.” For any given

Primary Users of the Data

	Data			
User of Data	Current Data	Trend Data	Other Historical Data	EFM Audit Trail Data
Operations and Maintenance	Daily Operations	Monitor Changes — Schedule Repairs		Correct and Verify
Billing			Yes	
Management	Yes	Yes	Yes	Yes
Business Planning			Yes	
Marketing		Yes		
Sales Yes				
Engineering		Yes	Yes	

new system a number of questions should be asked as a first step, and the famous "do you feel lucky? " should not be among them.

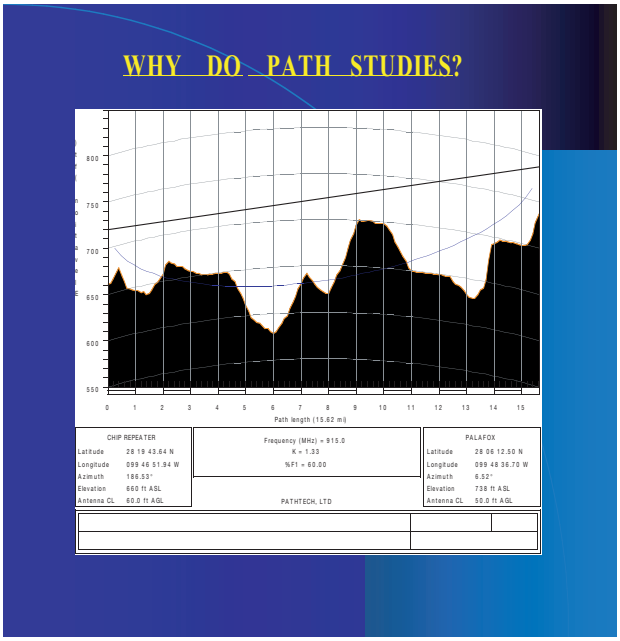
Questions that you'll be glad you got answers for include but are not necessarily limited to the following:



1. What is your objective – not generally, but with sufficient specificity to know when you have completed at least the first phase of the project. Into whose hands must what type of data be delivered and when? To whom shall be given what type of controls, if any? The chart shows some who are normally included in the plans.

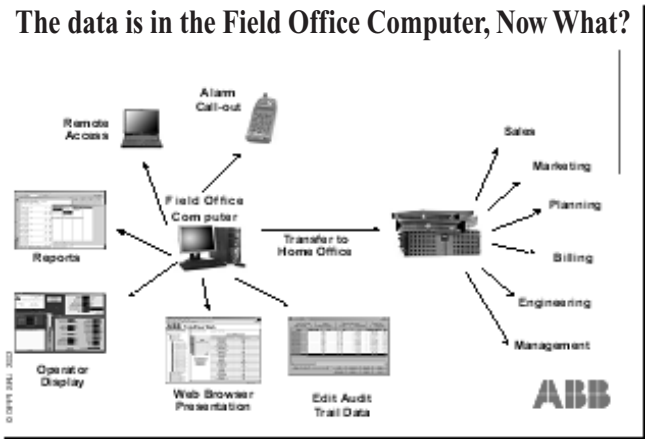
2. What resources are available? A/C power, a small building, a large building, cell phone service, tower space available for rent in the older 450Mhz. Or 800 Mhz. bands, licenses, protocol requirements, the compatibility of field devices with telemetry choices and most important—communications knowledgeable people, either yours or those from outside. Site survey work is nearly imperative.

3. In what environment must your system perform? At sea there are still distance limitations, especially in 900Mhz whose wavelengths provide line of sight operation. Do you have miles and miles of only miles and miles, or do you have trees and barns and mountains to deal with. Objects can stop; yes stop communications between two points requiring a repeater in some cases, or only an antenna height adjustment in others. How can you know the difference? Again, site surveys are nearly imperative.

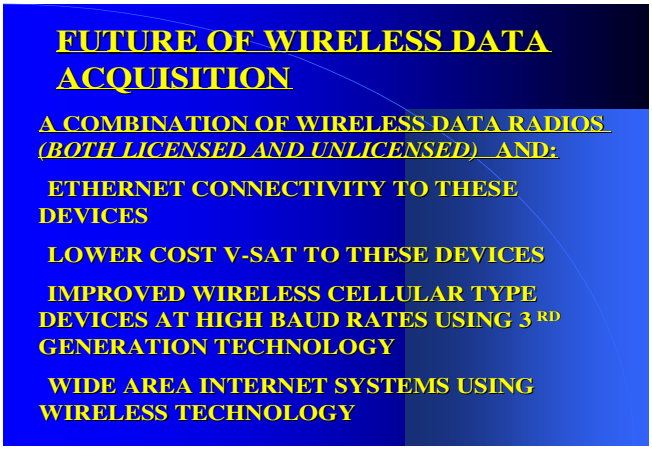


4. What are you willing to invest in a Measurement/ SCADA telemetry system to get the results you need or want? Have you and those you work with discerned the differences between needs and wants and what are acceptable costs for each? How much dependency on vendors are you willing to accept? That is to say, to what extent are you willing to design a system predicated on the viability of one central provider as opposed to leaving your options open with regard to expansion and vendor choice.

5. Once the field data is retrieved what will you do with it? The following diagram may provide a good starting point for discussing your needs.



The future of telemetry systems carries an element of further excitement, but should also be viewed with a degree of caution. Historically, there have been cases of premature exuberance, leaving buyers disappointed. Some of the future will likely materialize nicely, rewarding the participants handsomely.



Our industry has been committed to the advancement of technology for many years. We have set new standards of excellence in areas ranging from pipeline construction, to cat cracker operation, to hydrocarbon measurement and control systems. Often utilizing advanced software in remote devices and in telemetry, we get operating efficiencies elevated to higher levels with each passing year. Other hydrocarbon producing countries may not admit it, but this Yankee ingenuity has been and continues to be home in the USA.

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