Consultant's Corner

Aren't All Radio Systems Created Equal?

This article represents the combined effort of Neptune's Engineering, Sales, and Marketing personnel and is intended to provide a meaningful overview of the many entreés of radio systems in the field for application in the utility market. We hope it helps to clarify this technology as it is becoming increasingly complex.

"Aren't all radio systems created equal?" When you get right down to it, they all consist of a transmitter and a receiver. They all transmit meter reading data and an associated identification number. But that's where the similarities end.

The real measure of value in an AMR system is the value that the utility receives versus the cost of ownership. Many design factors play into how well a radio-based AMR system performs; and therefore, how much value it actually provides. Does the system use narrow-band or spread-spectrum transmissions? What is the transmitter's output power? How sensitive is the receiver? What is the battery warranty? Is the transmitter designed to last for 20 years in a rugged environment?

For a more detailed look at these design trade-offs, please refer to the Summer 2003 issue of *NeptuneNow* (**http://www.neptunetg.com/neptunenow.cfm?id=461&**). The focus of that article was how a true Hybrid AMR System will allow a utility to choose the most optimum method of reading their meters using any combination of technology — handheld, vehicle-based mobile, or fixed network — depending on the economics of the application. With the elements of radio-based system design we described in the article and the maturity of the AMR market, it is appropriate to examine what makes one radio-based system better than another.

Most current mobile AMR systems utilize transmitters that operate within the 902-928 MHz unlicensed radio frequency spectrum. This particular spectrum is governed by Part 15 rules of the Federal Communications Commission and fall into one of two groups:

- **FCC Part 15. 249** — Radios in this category are typically narrow-band (single frequency), low power transmitters (with output power less than 1 mW).
- **FCC Part 15. 247** — Because radios in this category use a spread-spectrum approach to avoid interference with other devices operating in this band (either frequency hopping, where the signal hops from one frequency to another, or direct sequence, where the signal is spread across the entire 902-928 MHz spectrum), they are able to transmit at power levels up to 1 Watt (up to a 1000 times more powerful than their FCC Part 15.249 counterparts!).

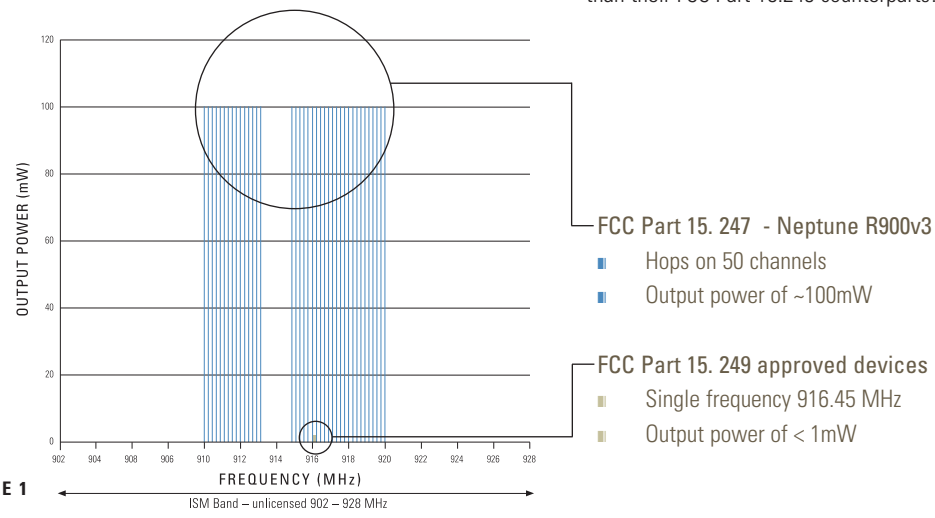

FIGURE 1

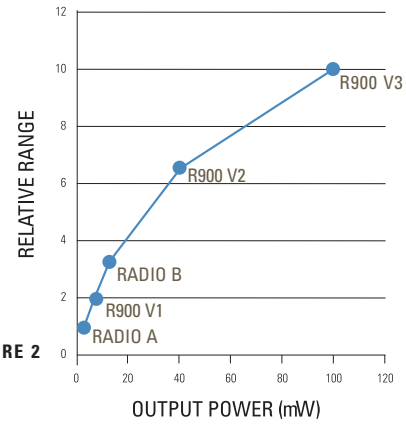

FIGURE 2

From Figure 1, the R900 has been designed so that it does not transmit in the 913-916 MHz range because —

1. Many garage door openers and cordless phones operate on frequencies in this area which can result in interference; and

2. Neptune's wireless inductive probes (the Advantage and Pocket ProReader RF) operate on 914 MHz. For applications that require a short range transmission of data such as Neptune's meter probing application, where ranges of three to six feet from the probe to the handheld are adequate, congestion of the RF spectrum in this area is not a significant issue.

However, for AMR applications where data transmission ranges of hundreds if not thousands of feet coupled with ability of the signal to penetrate building materials are required, RF interference of this type can diminish an AMR system's read success rate and overall performance substantially.

Output power of the transmitter is one of the key drivers of the range of the RF signal. The chart on page 5 (Figure 2) shows this relationship. Along with the various versions of the R900, we have also plotted (Radio A) low power devices that operate in the FCC Part 15.249 category, as well as Radio B which is another radio with 10 mW output power. The chart is in relative terms with the range of the Radio A being one (1) and other devices are multiples of that range. We can see that the range of the R900 v3 is about 10 times the range of Radio A, so that in a given application where all other factors are the same, if Radio A provides range of 200 ft, the R900 v3 should have range of 2,000 ft. Similarly, the R900 v3 should have about three times the range of Radio B.

"Range is important, but if I can get the reading from the street, isn't that really all I need?"

Not if the intent is to optimize read success rates and reading efficiency and, therefore, reduce reading costs. Consider Figure 3 in the graphic on the next page. A typical low power radio device installed on the outside wall of a house has a range of about one mile (in optimum conditions). In the same setting, the range of a typical radio with 100mW output power is about 1-3/4 miles. This difference in range has a significant impact on the efficiency of the reading system. In the sample route shown, the meter reader needs to drive almost every street in the route in order to capture the readings. On the same route, if high power radios such as the R900 are installed, the meter reader only needs to drive the streets around the perimeter of the neighborhood to complete the route. As a result the driving distance and reading time are reduced by approximately 40%!

Basics of an RF System: RF101

In the simplest of terms radio systems are extremely similar to voice systems. The transmitter (speaker) sends out a signal (voice) that sends data through the air (message / content). The receiver (listener's ear) converts the signal into useful information that can be interpreted by the receiver's computer / microprocessor (the listener's brain). The computer / microprocessor (listener's brain) stores the information for future use.

Much like voice communication, reliable radio communication depends upon several factors:

- Strength (output power) and modulation of the transmitted signal .
- Error correction methods embedded in the transmitted signal and used by the receiver to "fix" weak or corrupted signals into useful information.
- Noise that can prevent the receiver from hearing the transmitted signal.
- Collisions: where two or more signals collide with one another and never reach their intended destination.
- Fading: where two signals overlap one another and cancel one another out.
- Obstructions that reduce the range by absorbing or blocking the signal from reaching its destination.
- Sensitivity of the receiver: its capability to listen and hear the signal.
- Noise rejection of the receiver: the ability of the receiver to ignore ambient noise and only receive the intended signal.
- Capacity of the receiver: the number of signals a receiver can collect and convert in a given amount of time.

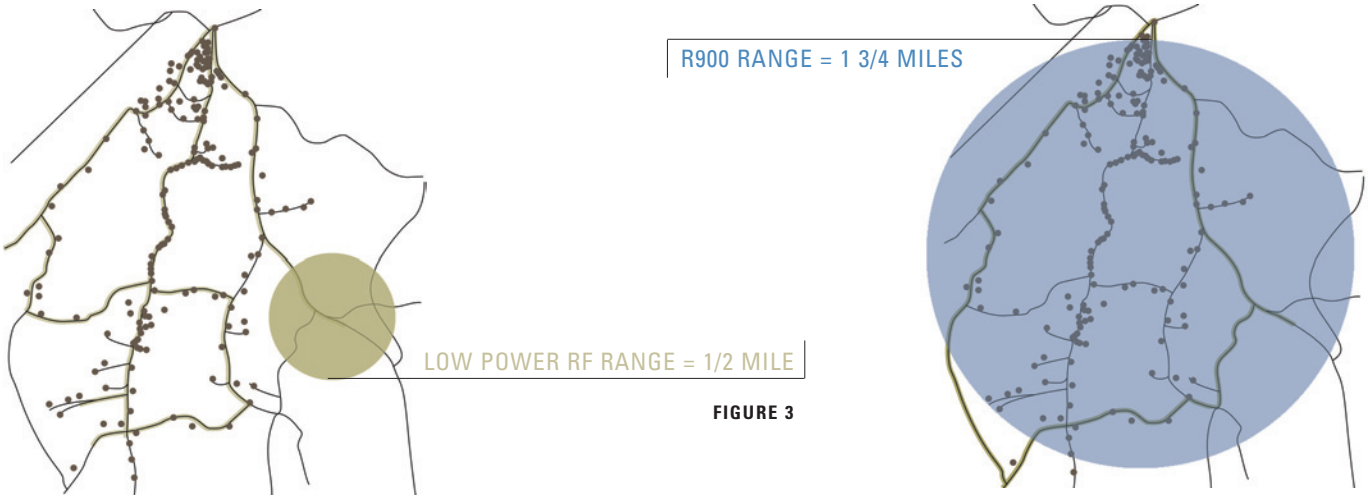

FIGURE 3

"If range is so important, why not increase the output power to the maximum allowed by the FCC?" Another key parameter to optimize life cycle costs is the battery life. If we increase the output power too much, we reduce the life of the battery considerably. The system has to have the right balance of range and battery life. To make sure the AMR provider has found the right balance, insist on a 20 year warranty.

In our article "Selecting an AMR System" that appears in this issue of *NeptuneNOW*, several examples of proposal evaluation criteria for evaluating an AMR system are listed as examples. As it pertains to the actual performance of an AMR system, the primary performance metrics that are specific to meter reading are:

- Meter Reading Success Rate – the percent of meters read divided by the number of meters in the route.
- Meter Reading Times – the elapsed time it takes to complete the meter reading route.

Other factors that are considerations of the cost of ownership of an AMR system include such items as:

Ease of Installation

- Does the supplier offer both a wall and pit mount configuration? (The environmental conditions are vastly different for each.)
- Is programming required?
- Are special tools required?

Reliability of the Radio Endpoint

- What are the terms of the warranty?
- What testing has the supplier done to validate that their packaging is fit for the application? (What good is a warranty if the product fails and you have to visit the endpoint to replace it every five to seven years?)
- What testing has the supplier done to validate their battery life?

In order to properly assess which AMR technology is best for your utility's meter reading application, it is best either to conduct site visits to other utilities using the products under consideration or to run your own comparison test or trial. In the case of running your own comparison test or trial, it is important to test your worst case applications such as those that are near cellular or pager towers, below grade installations, backyard installations, inside buildings, flooded pits, etc.

A QUICK COMPARISON OF RF TECHNOLOGIES IS OFFERED IN THE TABLE BELOW:

	FCC Part 15. 249	FCC Part 15. 247
Signal Strength or Output	Power Up to 1 mW. The limit on the output power limits the range of the device and also limits the ability of the signal to penetrate building materials.	Up to 1 Watt, but for practical purposes for optimum battery life and range in an AMR application > 10mW and < 200 mW. The higher output power enhances range and makes the signal capable of penetrating building materials better.
RF Interference (Noise) and Collisions	The radio signals are typically narrow band or single channel. These devices are susceptible to interference and jamming by other signals that may be on the same frequency. Single channel devices by their nature are also susceptible to collisions (where two RF devices transmit on the same channel at the same time) in highly congested RF environments.	Spread Spectrum signals, either frequency hopping or direct sequence, are not as susceptible to interference or collisions.
RF Devices by Category	Examples of devices that fall within the FCC Part 15.249 category – low power devices. Badger Orion Ramar Transpondit Datamatic Firefly Itron ERT model 50W	Examples of devices that fall within the FCC Part 15.247 category – higher power devices. Neptune R900 Sensus MXU Itron ERT model 60W