Wireless Communications

(continued from page 3)

from either other radios in the area or from outside sources in adjacent bands such as cell phone operating frequencies. If interference exists, a frequency hopping radio will keep re-transmitting data packets on different sub-bands until the data gets through. The result can be a reduction in data throughput, but rarely a complete failure of the system. Direct sequence will usually provide higher absolute data throughput, but can be overwhelmed by noise in which case data throughput can drop to zero. Unless there is a requirement for very high data rates, frequency hopping radio modems (operating the 900 MHz band) are usually the best choice for the typical RTU. Frequency hopping radios are available with data rates from 9600 bits per second to over 1 Megabits per second and have either RS-232 serial or Ethernet interfaces. 2.4GHz direct sequence are now available with data rates up to 54 Megabits per second (theoretical, noise free and short range of a few hundred feet conditions) but real world RTU operation would likely be in the 1 to 20 Megabits per second depending on quality of the RF link.

In addition to licensed and unlicensed radios, which involve private networks and user control over system reliability, there are two other choices. One is cellular and the other is satellite communication. With cellular data packet services, data is collected and typically stored on an Internet web site. Initial cost may be low, but operating costs are usually based on a per packet charge. Reliability of service is dependant on cell phone coverage and the service providers operations. The major advantage of satellite radio communications is that it is rarely limited by topography and is universally available even in very remote locations. Satellite communications is generally the most costly and most RTU applications avoid using this method when possible.

Wireless Ethernet Application Using FHSS

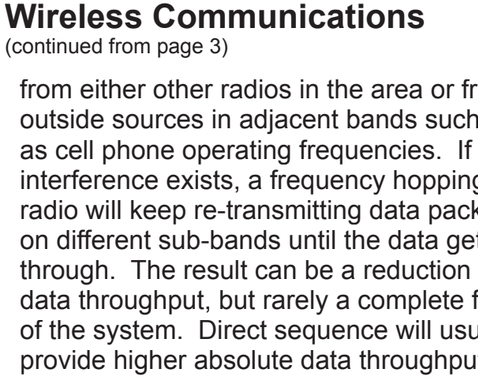

Diagram 3 A typical equipment arrangement for a multi-drop wireless SCADA system using frequency hopping modems.

Wireless Ethernet Application Using IEEE 802.11g/b

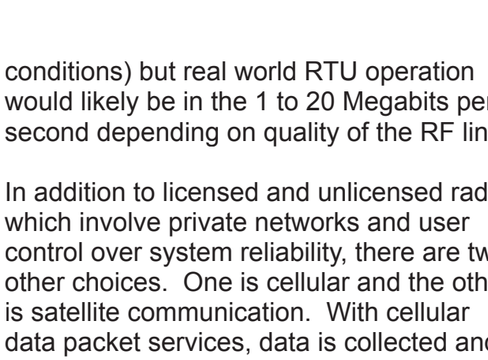

Diagram 4 An equipment arrangement for a multi-drop high speed wireless system which includes laptop computer wireless integration utilizing.

DATA-LINC GROUP

Technical Paper

Designing the Ultimate RTU— Communication Options

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Abstract- A broad range of communication options are available for SCADA systems to transfer data from Remote Telemetry Units (RTUs) to a central location for system monitoring, process control and data logging. The selection of an appropriate communication method is dependent on many factors including distance between the RTUs and the central location, the existence or absence of wires or fiber optic cable for communication, data speed required, topography and economics.

Telephone Line, Dedicated Wire & Fiber Optic Methods

When data rate requirements are low (1200 to 19,200 bits per second) and either private or Telco wires are available, several types of wire modems will fit the purpose. With Telco lines (which will have ongoing monthly charges associated them), dial-up modems, which usually involve the lowest monthly cost, can be used if connection time delays of typically 30 to 60 seconds can be tolerated in the application. Otherwise, leased line modems, which are always on line and therefore have lower data delays, are an option. If the Telco leased lines are loaded, communication distance is unlimited as the telephone company will amplify the signal. With private lines (dedicated wires), there is no monthly fee, and private line modems are also always on-line and have relatively short connection delays of 50 ms. Private line modems have typical practical ranges of 4 to 25 miles depending on modulation type and data rate.

Direct Ethernet wire connection can be made over modest distances of 300 feet on CAT5 wire. Fiber optic modems are available with either serial (RS-232) or Ethernet if cable is in place or can be economically installed. Fiber optic cables provide the highest speeds

(Continued on page 2)

Wired & Fiber Communication Comparison

	Dialup	Leased Loaded	Leased Unloaded	Private	DSL / Cable	Private Fiber
Comm Type	Periodic	Continuous	Continuous	Continuous	Continuous	Continuous
Architecture	P2P	P2P P2MP	P2P P2MP	P2P P2MP	P2P P2MP	P2P P2MP
Speed	Low	Low	Low	Low	High	High
Distance	Unlimited	Unlimited	Miles	Miles	Unlimited	Miles
Initial Cost	Low	Low	Low	High	Low	High
Periodic Cost	Medium	Medium	Medium	Low	High	Low

Table 1 The principle characteristics of each of the options.

Telephone Line, Dedicated Wire & Fiber Optic Methods

(continued from page 1)

and offer long distances, but are costly to install and difficult to repair if damaged.

One additional option is DSL/Cable where such service is available. This option has high speed, unlimited distance (where service is provided), relatively low initial cost but rather high monthly expense. Since communications is provided by a third party, data communication interruption can occur without notice.

Dial-up Telephone Line Application

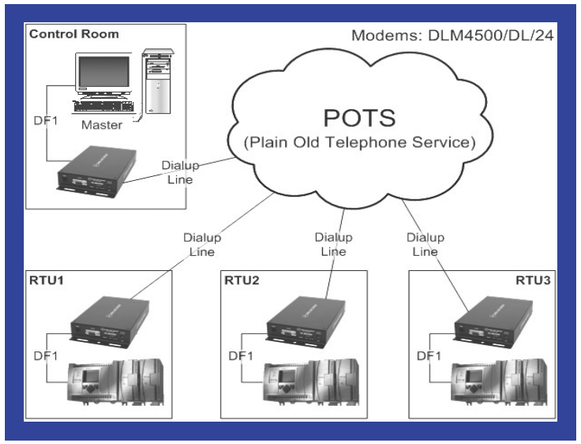

Diagram 1. A typical dial-up communication system where the control room computer dials each RTU to establish a temporary point-to-point session.

Leased Line Telephone Line Application

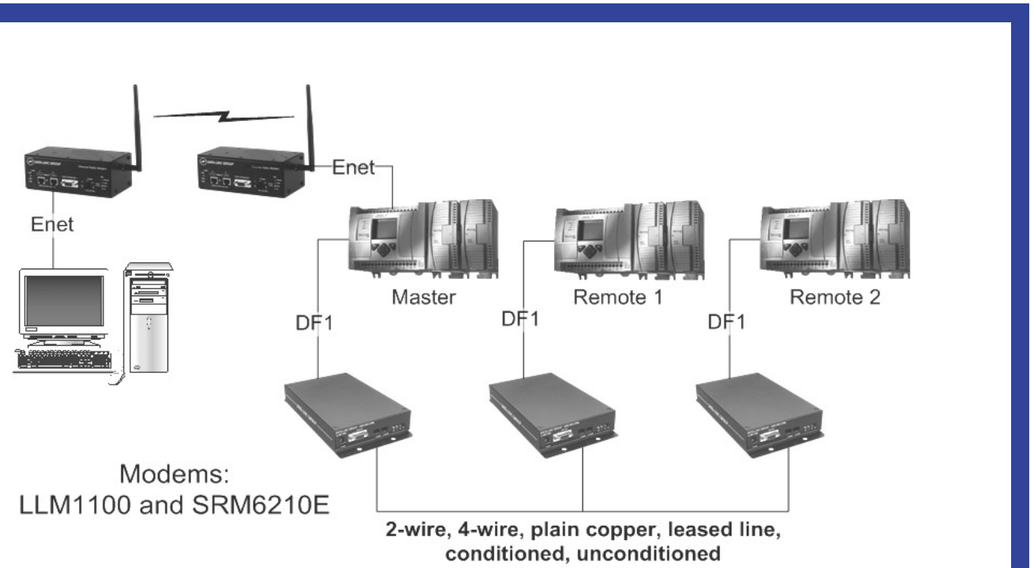

Diagram 2. A point to multi-point leased line or dedicated copper system where each RTU is polled by the master computer. Communications are continuous in this system. The diagram also shows how a wireless Ethernet link may be used to access the system.

Wireless Communications

Wireless communication methods offer considerable advantages over hardwired or telephone based methods and are gaining popularity in industry. Wireless technologies are versatile, most provide high data rate and generally are easy to deploy. There are many varieties of wireless technologies, both private (licensed and unlicensed) and subscriber based.

Licensed wireless modems require FCC operating licenses. They typically operate in the 200MHz to 400MHz frequency bands which enables them to operate at long distances without line-of-sight. Their two primary disadvantages are the requirement to apply for and maintain an operating license and their low data throughput of typically 9600 bits per second or less. In certain locations, the unlicensed bands are completely filled and no new licenses are available.

Unlicensed wireless modems have become very widely used because they do not require an operating license and have much higher data rates, typically 115.2 Kilobits per second to many Megabits per second. In the Americas and a few other countries, they operate in the 902–928 MHz or 2.400-2.483 GHz band. In most of the rest of the world, only the 2.4GHz band is permitted. The 900 MHz band is preferable for RTUs as it is somewhat less dependant on true line-of-sight and the range is over twice that of 2.4 GHz radios at maximum effective transmit power of 4 watts in North America.

Unlicensed wireless modems utilize one of two types spread spectrum technology. The objective of spread spectrum technology is to allow many wireless modems to operate simultaneously without interference. One method is called direct sequence and the other frequency hopping. It is beyond the scope of this paper to discuss the two types of spread spectrum except for a few important characteristics.

Frequency hopping spread spectrum is generally considered to be the most robust with higher immunity to interfering noise

(Continued on page 4)

Wireless Communications Comparison

	DSSS	FHSS	Licensed (narrow)	Celular	Satelite
Comm Type	Continuous	Continuous	Continuous	Periodic	Continuous
Architecture	P2P P2MP	P2P P2MP	P2P P2MP	P2P P2MP	P2P P2MP
Speed	Ethernet	Ethernet	Serial	Serial	Ethernet
Distance	10 miles	35 miles	50 miles	Depends	Far
LOS	Must Have	Partial	No	Partial	To Sky
Initial Cost	Medium	Medium	Medium	High	High
Periodic Cost	None	None	Low	High	High

Table 2 The principle characteristics of each wireless communication method

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