A Proposal for a Standard Digital Radio Interface

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Introduction

Just about everyone who has ever used packet radio has had to deal with what should be a simple task: that of properly connecting radios and terminal node controllers (TNCs) together. Unfortunately, many people have learned that it is not very simple. Not only do the proper signal connections need to be determined between each radio and TNC but the correct audio levels must be set in order for the system to work well. This problem is compounded for persons with multiple TNCs or multiple radios. Every time a radio or TNC is changed, the system must be readjusted for proper receive and transmit audio levels, as well as proper delay times to accommodate the key-up time of the transmitter. These problems are exacerbated by the existence of differing connectors for different models of radios and TNCs. All of this can be attributed to the fact that the interface between the equipment uses analog signals despite the fact that packet radio is a. mode of digital communications. For operation at speeds greater than 1200 bits per second (b/s) most radios do not even provide a connector for the appropriate signals. Operators of digipeaters or remote sites are burdened with the task of hauling around extra test equipment and adjusting radios on-site instead of performing these adjustments in a convenient location such as a laboratory or home station. Emergency operation is difficult because it is almost impossible to properly connect various equipment quickly in the field unless the exact configuration is known beforehand.

In this article a proposal for a digital radio (DR) interface is developed. This interface is designed to support all current packet modulation methods and speeds and any which can be reasonably anticipated for future use. It provides “plug and play” operation between any digital radio and TNC (from here onward the term TNC refers to a TNC or any other device, such as computer or packet switch, which processes the data being communicated). It can be easily incorporated into most of the current equipment and it allows the use of a single radio in multiple packet modes without changing cables or making any adjustments.

Requirements

The requirements of the interface are as follows:

- connect any DR to any TNC;
- be transparent to the data stream;
- operate over a wide range of speeds;
- operate with both synchronous and asynchronous modulation modes;

- operate in both full- and half-duplex modes as well as in transmit-only and receive-only systems;
- provide good immunity to electromagnetic interference (EMI);
- be tolerant of variations in the equipment: not require any adjustments when equipment is changed;
- operate over cable distances from zero to at least 10 meters;
- be usable for all existing digital communications modes and for all anticipated modes in the future;
- operate at all existing speeds and at all reasonable future speeds, at least up to 2 Mb/s;
- have a single standardized connector so that connection is "plug and play;"
- sense when cable is disconnected or when the DR is powered down;
- make use of existing standards, where possible; and
- allow easy migration from the current system.

Development of the Interface

In a digital communications system the digital information is communicated by representing the information as an analog signal. For the interface the simplest representation should be used for the information being sent: this is a serial bit stream. To do this, it is necessary to move the "modem" out of the TNC and into the DR This change has a benefit of making the dual use (voice and data) of the radio easier to accomplish. A front panel switch could easily select between voice and one or more data modes; for example, a 2-m radio might be built to support voice, 1200 b/s packet and 9600 b/s packet.

Many standards have been developed for use in data communications. Some standards which are related to the needs of this interface are EIA/TIA-232, EIA/TIA-422, EIA/TIA-423, CCITT V. 10, V. 11, EIA/TIA-449. There appears to be no standard which provides the necessary functionality; however, some standards can be incorporated into the interface.

Examination of the information which must be communicated across the interface yields the required signals. The fundamental information which must be conveyed across this interface is receive data and transmit data. Auxiliary information is necessary to indicate where each data bit is, when the data is valid, and when the data can be sent and received. To accommodate both synchronous and asynchronous systems at varying speeds a synchronous interface is used. The receive and transmit clock signals originate at the digital radio and are independent of each other.

To send data from the DR to the TNC the following items are necessary:

- Receive Data: the data from the DR to the TNC.
- Receive Clock: a clocking signal for the receive data, originating at the DR.
- Receive Data Valid: a signal originating at the DR which indicates that the receive data signal is valid (similar to carrier detect).

To send data from the TNC to the DR the following items are necessary.

- Transmit Data: the data from the TNC to the DR.
- Transmit Clock: a clocking signal for the transmit data, originating at the DR.
- Request To Send: a signal from the TNC to the DR indicating that data transmission is requested.
- Clear To Send: a signal from the DR to the TNC indicating that data transmission may proceed.

One other signal is necessary to convey the DR status to the TNC.

- DR Ready: a signal from the DR to the TNC indicating that it is powered up and capable of reception and/or transmission of data.

The Interface Proposal

The signals listed above will be sent using a combination of EIA/TIA-422 (differential) and EIA/TIA-423 (single-ended) signal levels. The two data signals and two clock signals, because of the potentially high speed will use differential signaling, which provides for speeds of up to 10 Mb/s. These signals will use eight wires of the interface. The status signals will use single-ended signaling because high speed is not necessary. These signals will use four signal lines and two ground lines (one in each direction, per EIA/TIA-423 specifications). To insure proper operation under fault conditions (either unit is powered down or the cable is not connected) “fail safe” line receivers must be used for the four status signals (RDV, RTS, CTS, and DRR).

Much of the delay necessary at the beginning of the transmission are due to internal delays in the transmitter. This delay is made the responsibility of the DR rather than the TNC. When CTS becomes active, data can be sent immediately; after the last bit of data has been sent, RTS may become inactive. Additional delay may be added in the TNC (as is done currently).

The physical connector selected is a high--density 15-pin D-series connector. This connector is small enough to be used on mobile and portable equipment and yet it reasonably rugged, reliable and inexpensive. The male connector (plug) is used on the TNC and the female connector (socket) is used on the DR. Although the same type of connector is popular for computer displays., the opposite sex connector is used on the computer so that confusion should not occur. Cables will. act as “extension cords,” that is they pass all pins straight through from the connector on one end to the other end. The shell of the connector must be used for the shield connection if a. shield exists on the cable; if no shield exists the shells must be connected by a wire in the cable, All DRs and TNCs must have metallic connector shells so that shielded cables can be used effectively.

Alternative Interconnections

Although the interface is specifically designed to connect a DR to a TNC, it can be used to connect two DRs or two TNCs together or it can be used in a transmit-only or receive-only system. To connect two DRs together there needs to be a adapter which contains a FIFO large enough to accommodate the largest packet at the maximum speed differential between the systems. To connect two TNCs together there needs to be an adapter which generates appropriate clock signals. The receive and transmit signals are independent of each other so they can be running at different speed or be going to different DRs; use in a transmit- or receive-only system is also possible (a protocol other than AX.25 will be necessary in this case).

Incorporation Into New and Existing Equipment

This interface can be incorporated into new radio designs by including the “modem” with the radio and providing a method for switching modes (e.g., voice, 1200 b/s data, 9600 b/s data). Most TNC designs can be updated quite easily to incorporate the interface without eliminating any current features.

Most existing systems can be easily modified to use the new standard. It appears that the PackeTen, DataEngine, PI, PI2 and PackeTwin cards and Kantronics DataEngine modems require very little modification as the appropriate signals are available to easily add the interface; the only significant change is that with the new interface the modem is physically housed with the DR, not the TNC. In general, any modem which performs clock recovery can be easily modified for use with this interface. Any TNC which provides the “modem disconnect header” can have the interface added to it by using that connector. A smooth transition from the current system to using the new interface can be made by providing adapter kits for common modems and TNCs so that current equipment will not be obsoleted.

Summary

The interface proposal presented here will solve the problem of connecting digital radios and terminal node controller or computer equipment together. It provides a simple, inexpensive, versatile, and easy-to-use solution. It is applicable to all current packet radio systems, as well a other digital systems and it does not inhibit future improvements to packet radio systems, either in the modulation and coding techniques or in the protocols. While the exact specifications remain to be finished and tested through implementation, much existing technology is being used and no problems are anticipated. The author welcomes suggestions for the improvement of this interface and is interested in hearing from a few persons who are willing to design and test interfaces for various modems and TNCs.