Overview of ARRL Digital Committee Proposals for Enhancing the AX.25 Protocols into Revision 2.1

Eric L. Scace K3NA
10701 Five Forks Road
Frederick MD 21701
USA

0. Summary

A working group within the ARRL Digital Committee has been evaluating enhancements and other proposals for improving AX.25. This paper summarizes the most significant items which are being proposed. You are invited to comment on these proposals. Comments are desired so that any final recommendations by the Committee will benefit from the broadest possible input.

The main topics of discussion have included:

a) improving the channel utilization on busy radio frequencies (e.g., the typical 2 meter simplex channel).

b) cleaning up of minor bugs or ambiguities in the Revision 2.0 specification.

c) suppressing tendencies for connections, under poor conditions, to reappear after disconnect procedures were executed ("Night of the Living Connection").

d) providing support for longer radio callsigns, such as FG/KA3EEN/FS7.

e) providing a mechanism for parameter negotiation between two consenting stations.

f) providing for larger maximum frame sizes, when appropriate.

g) reducing the processing burden for TNCs serving higher speed links (e.g, multiple 64 kbit/s links in a network backbone environment), providing more effective operation on HF radio circuits, and providing better support for information broadcasting applications such as DX spotting networks and QST bulletins.

A key objective of the Committee in considering all of the proposals received was to avoid impact on existing implementations. Every change accepted by the Committee is "backwards compatible"; i.e., an implementation with the feat described below can also successfully connect to, receive connections from, and exchange data with existing AX.25 Revision 2.0 implementations.

1. Improving Channel Utilization

Several mechanisms have been included to improve performance on busy channels.

Round trip timing is measured on a per-connection basis. When frames are transmitted for which an acknowledgement is expected, the time between transmission of the frame and receipt of the acknowledgment is measured. A smoothed average is calculated, using the algorithms described by Phil Karn [correspondence dated 87 Jun 15]. The retry timer value T1, on the first attempt, is set at twice the smoothed round trip time. Details are provided in the companion paper describing the AX.25 data link machine.

Subsequent retransmissions of the same information employ longer Tl values; i.e., larger multiples of the smoothed round trip time. This allows for situations where the channel has become busier. When round trip times improved, the smoothing algorithm automatically begins reducing the retry timer value. Details are found in the companion paper describing the AX.25 data link machine.

AX.25 data link timers are now suspended when a simplex channel is occupied, and timing resumes when the channel becomes idle. This prevents retry timers from expiring during busy periods and triggering retransmissions, when the difficulty is that the remote station just did not have an opportunity to transmit its acknowledgement. Details are provided in the companion paper describing the AX.25 data link machine.

Algorithms for handling multiple simultaneous links in a station are also included. These algorithms provide a round-robin rotation through each data link with traffic to send, prevent any one link transmission from hogging a channel, and relinquish the channel for re-contention after transmission to a particular station. The objective is to give equal opportunity for all links from all stations to use the channel. Details are provided in the companion papers describing the link multiplexor function and the simplex physical channel handler.

For simplex channels, a p-persistence algorithm has been added [Chapponis & Karn, 6th Computer Networking Conference]. This algorithm permits the channel to become more heavily loaded with users without congestion collapse. Details are provided in the companion paper describing the simplex physical channel handler.

2. Cleaning Up Bugs and Ambiguities

Various minor bugs and ambiguities have been clarified in the prose description. The revised prose description has been prepared by Terry Fox, and should be found elsewheres in these Proceedings.

In addition, the Committee has reviewed an extended finite state machine description of the AX.25 protocol. This description follows the graphic conventions of the 2.100 series of Recommendations of the International Telegraph and Telephone Consultative Committee (CCITT), known as System Description Language (SDL). SDL was developed specifically for describing telecommunications protocols. The Committee now proposed to completely replace the present state tables (recognized to be incomplete in some areas, and containing some errors in others) with the SDL descriptions. The SDL descriptions are provided in a series of companion papers.

3. Suppressing the Connection Which Never Dies

During review of the AX.25 SDL diagrams, adjustments were made to disconnect a data link connection under certain error conditions. The previous prose and state table descriptions, as well as implementation decisions made by some designers, had caused disconnected links to unexpectedly reconnect. Unexpected reconnections usually appeared on margin al channels suffering frequent time-outs. These adjustments, plus the improvements described in **§1 above, are** expected to eliminate this minor problem.

4. Longer Callsigns

By far, the most difficult challenge facing the Committee was to find a solution for handling longer callsigns in AX.25 frames which would be compatible with existing implementations. The principle of backward compatibility imposed considerable constraints on this solution which were almost impossible to overcome.

The problem arises when AX.25 is employed in non-amateur radio situations, where callsigns (or “tactical identifiers”) of more than six characters are encountered; e.g., “HQ-WASHINGTON” and "KSGY1497". The problem also arises when AX.25 is used by amateur radio stations operating under certain reciprocal agreements which require: a longer callsign to be used as the legal identification of the station; e.g., FG/KA3EEN/FS7, to pick an extreme case.

The resulting proposal solves the problem by hiding the additional characters of the callsign as a fake digipeater field. Clever positioning of this extension field allows the frames to be digipeated by existing AX.25 implementations. Furthermore, the extension field is *only* included when a callsign is longer than six characters; this means that the vast majority of frames will continue to use address fields of the same form as seen today.

The Committee was unable to achieve 100% backward compatibility with existing implementations in one area. If a “new” implementation attempts to connect to an “old” implementation (or vice versus), the “old” implementation will not properly handle the callsign extension. The workaround is for the “new” implementation to fallback into the existing callsign format when it has been unsuccessfully attempting to complete a connection. The fallback will truncate the callsign to the, first six characters.

This fallback limitation was felt to be acceptable, considering:

a) the vast majority of situations are already handled with 6-character callsign fields, even in non-amateur environments.

b) channels using “tactical” addresses (which tend to be longer) are usually a more controlled environment where the network implementor can equip all stations with “new” implementations.

c) digipeaters are unaffected.

d) the extension mechanism automatically kicks into play only when required; e.g., when the amateur radio operator travels and operates under a reciprocal operating permit which requires the addition of callsign prefixes or suffixes.

e) if an incompatibility between implementations is detected (by a failure to connect successfully), a graceful and automatic fallback to a compatible mode has been provided.

The details of the extension mechanism have been prepared by Terry Fox, and should be found elsewheres in these Proceedings.

5. Parameter Negotiation

Various requests for automatic negotiation of data link parameters have been made. The Committee is proposing to include a negotiation mechanism, based on the HDLC XID frame plus CCITT Q.913 l-style parameter formatting within that frame. Negotiation will only be available between stations operating with “new” implementations; the XID frame will be ignored by existing implementations while the data link connection is in the disconnected state. To maintain backwards compatibility, XID frames will be sent only in the disconnected state; i.e., negotiation occurs automatically and prior to link connection establishment (before SABM).

Presently, the proposal includes negotiation or notification of the following parameters:

a) **N1,** maximum size of the information field within a frame; but see also the discussion of **frame** size in 96 below.

b) initial value of round trip timers.

c) transmission speed; this allows an increase (or decrease, if conditions degrade) in transmission speed to occur automatically between compatible stations.

d) use of segmentation procedures; see **§6** below.

e) window size.

It was also agreed ***not*** to include a field for manufacturer proprietary operating modes. It was felt that such proprietary operating modes would potentially segment the TNC population into incompatible subgroups. Such subgroups could not only prevent communications between various implementations, but also potentially interfer with the communications within another subgroup on shared radio channels.

Due to the tight time schedule between the Committee's working group meeting and the publication deadline for these Proceedings, it was not possible to complete a paper detailing the entire proposal. I hope to be able to provide the entire proposal as a handout at the Conference.

6. Larger Frame Sizes

The support of larger frame sizes, like the **callsign** extension problem, carries backward compatibility difficulties. Existing AX.25 implementations which perform a digipeating function will not support larger frames, even if the source and destination stations are both prepared to accept them.

Therefore, the Committee is proposing to retain the existing **N1** value at the 256 octet limit. This limit applies to the information field within I and UI frames; the flags, address fields, frame check sequence, and O-bits added for transparency are not included in calculating the limit.

However, the Committee is also proposing to permit larger **N1** values between "consenting stations"; all stations in the connection, including digipeaters, would need to be configured for the larger value. The parameter negotiation procedure discussed in **§5** above is one way to obtain "consent".

An additional mechanism is proposed to support applications desiring to transfer larger units of data, while living within the present constraints of **N1.** This mechanism is a segmentation procedure. The transmitting procedure accepts the large data unit from the application and segments it into multiple smaller frames (I or UI) for transmission by **AX.25.** The receiving procedure accumulates segments together and then delivers the reassembled large data unit to the destination application. A few octets of overhead are added to maintain segment integrity. The transmitting segmentor alerts the receiver as to the total number of segments to be transferred, and then transfers all segments without interruption. This prevents deadly embrace buffer lockouts. Digipeater operation is unaffected.

The exact segmentation procedure has been standardized by the **CCITT** in Recommendation 4.931. Again, due to the tight time schedule between the Committee's working group meeting and the publication deadline for these Proceedings, it was not possible to complete a paper detailing the entire proposal. I hope to be able to provide the entire proposal as a handout at the Conference.

7. Higher Speed Operation, Other Types of Links, and Packaging

Finally, it was noted that the amount of computing time devoted to frame analysis could be reduced if certain changes in the format and structure of the link frames were made. Computing time constraints become more important when **TNCs** support multiple link and multiple radio channels at speeds of 56 **kbit/s** and above.

Such changes would be fundamentally incompatible with existing implementations.

Therefore, the Committee is proposing to package the enhancements described in **§§** 1 through 6 above (i.e., not including changes in format to reduce computing time) as a Revision 2.1 for **AX.25.** Revision 2.1 is felt to be fully backwards compatible with existing Revision 2.0 implementations.

The Committe **will be continuing to evaluate new** ideas for:

a) a more compute-time efficient data link protocol for higher speed operation (see other papers within these Proceedings);

b) a data link protocol which would be more effective on HF radio circuits than the present **AX.25;** and,

c) adjuncts to AX.25 which would be more effective for information broadcast applications, such as **DX** spotting clusters and "QST" bulletin dissemination.