

# **APRS<sup>®</sup> & AX.25 Protocols**

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# APRS® & AX.25 Protocols

- ◆ X.25 and AX.25 origins
- ◆ KISS TNC Protocol details
- ◆ APRS Protocol details
- ◆ Problems with implementation and use
- ◆ References and additional resources

# X.25 and AX.25 origins

- ◆ X.25 ITU Standard for Packet-Switched Network (CCITT 1976)
- ◆ Designed for use within the telephone system
- ◆ Lower 3 layers of OSI Net Model plus a bit more (L1 Physical, L2 Data Link, L3 ~ Packet)
- ◆ Widely used 1976 to mid 1990
- ◆ Mostly replaced by Frame Relay in 1990's
- ◆ Still used by Credit Card Terminal Processors

# X.25 and AX.25 origins

## ◆ X.25 provides

- Part of a suite of protocols that work together
- Call setup & teardown (like a telephone call)
- Error detection & correction, flow control
- Designed for channels with long delays (great for communications satellites)
- Manages Virtual Circuits (VC) and PVC
- Supported billing (Phone Co)
- 2400bps to 2Mbps, 64Kbps typical

# X.25 and AX.25 origins

- ◆ AX.25 based on X.25 (minor differences)
  - Version 2.0 by Terry Fox WB4JFI in 1984
  - Version 2.1 July 1993
  - Version 2.2 1996 (11 Nov 1997)
  - Version 2.2 July 1998

# X.25 and AX.25 origins

- ◆ AX.25 based on X.25 (minor differences)
  - Address Field- Instead of phone numbers as in X.25 we use Call Signs, SSIDs
  - Digipeating uses up to 8 fields for Call Sign and SSID
  - Mic-E encodes part in DST Field

# AX.25 Frame

## 3. Frame Structure

Link layer packet radio transmissions are sent in small blocks of data, called frames.

There are three general types of AX.25 frames:

- a) Information frame (I frame);
- b) Supervisory frame (S frame); and
- c) Unnumbered frame (U frame).

Each frame is made up of several smaller groups, called fields. Figures 3.1a and 3.1b illustrate the three basic types of frames. Note that the first bit to be transmitted is on the left side.

Flag	Address	Control	Info	FCS	Flag
01111110	112/224 Bits	8/16 Bits	N*8 Bits	16 Bits	01111110

*Figure 3.1a. U and S frame construction.*

Flag	Address	Control	PID	Info	FCS	Flag
01111110	112/224 Bits	8/16 Bits	8 Bits	N*8 Bits	16 Bits	01111110

*Figure 3.1b. Information frame construction.*

# AX.25 DST Address Field

## 3.12.2. Destination Subfield Encoding

Figure 3.5 shows how an amateur callsign is placed in the destination address subfield, occupying octets A1 through A7.

Octet	ASCII	Bin Data	Hex Data
A1	N	10011100	98
A2	J	10010100	94
A3	7	01101110	6E
A4	P	10100000	A0
A5	space	01000000	40
A6	space	01000000	40
A7	SSID	11100000	E0
A7	SSID	CRRSSID0	

Bit position 76543210

Figure 3.5. Destination field encoding.



# AX.25 SRC Address Field

## 3.12.3. Source Subfield Encoding

Figure 3.6 shows how an amateur callsign is placed in the destination address subfield, occupying octets A1 through A7.

Octet	ASCII	Bin Data	Hex Data
A8	N	10011100	98
A9	7	01101110	6E
A10	L	10011000	98
A11	E	10001010	8A
A12	M	10011010	9A
A13	space	01000000	40
A14	SSID	CRRSSID0	

Bit position      76543210

Figure 3.6. Source field encoding.

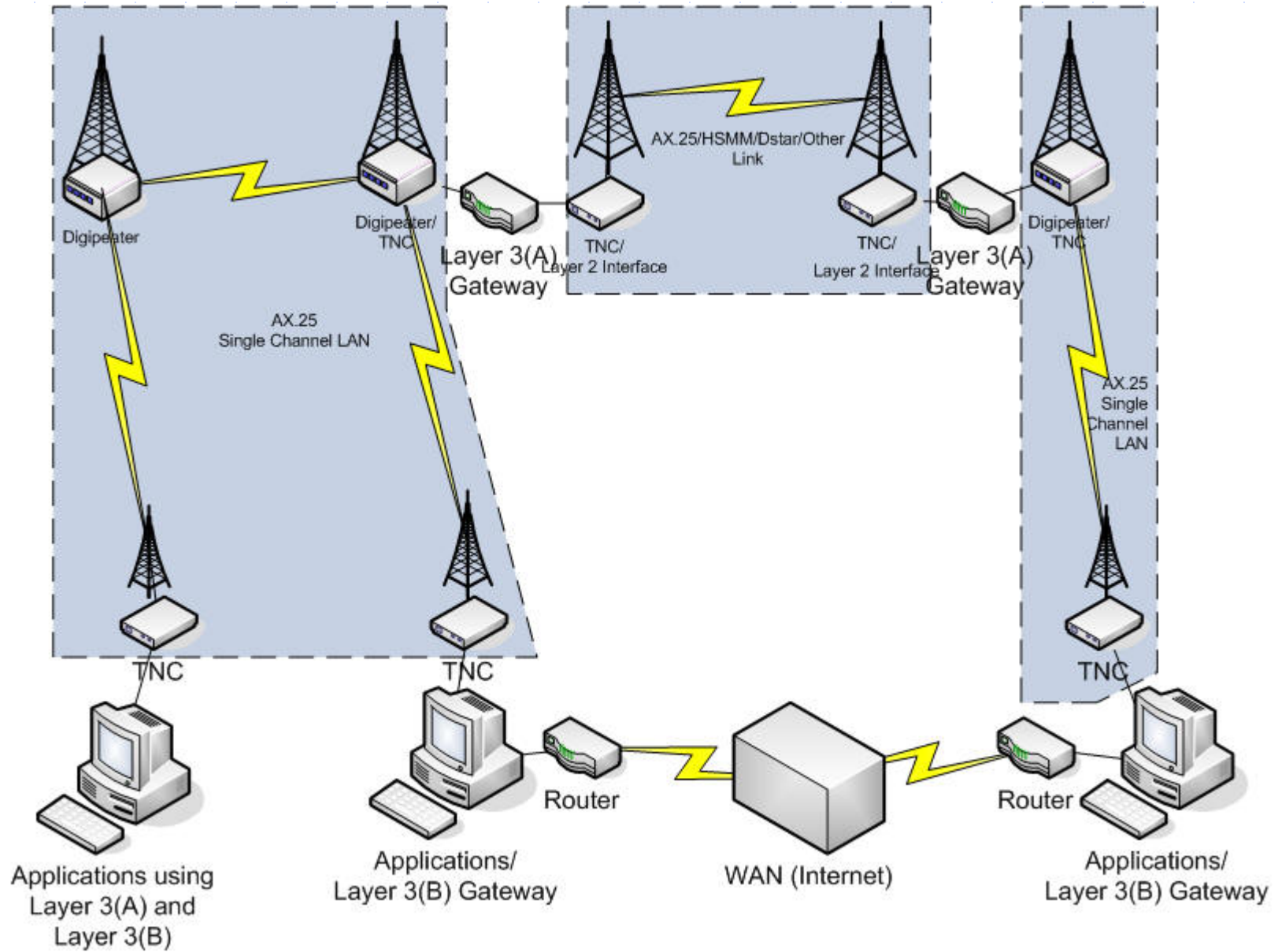
# AX.25 Digi Path Field

Figure 3.7 shows how the repeater address subfield is encoded. Figure 3.8 is an example of a complete frame after being repeated.

Octet	ASCII	Bin Data	Hex Data
A15	N	10011100	98
A16	J	10010100	94
A17	7	01101110	6E
A18	P	10100000	A0
A19	space	01000000	40
A20	space	01000000	40
A21	SSID	HRRSSID1	

Bit position      76543210

*Figure 3.7. Repeater address encoding.*



# KISS TNC Protocol details

- ◆ Keep It Simple Stupid TNC
- ◆ Brian Lloyd WB6RQN idea
- ◆ Mike Chepponis K3MC & Phil Karn KA9Q Aug 1986
- ◆ Presented at ARRL Computer Net Conference 1987
- ◆ Takes the "Human Software" out of TNC
- ◆ Removes AX.25 code from the TNC and expects it to be in the host computer
- ◆ Interfaces to computer with encapsulated HDLC frames
- ◆ Converts to/from sync/async
- ◆ No error detection
- ◆ Phil apologizes for leaving out flow control

# KISS TNC Protocol details

- ◆ Provides KISS TNC controls:
  - Data frame
  - TXDELAY byte in 10ms units
  - P persistence parameter
  - SlotTime byte in 10ms units
  - Txtail byte in 10ms units to hold TX
  - FullDuplex 0 is full, nonzero is half
  - SetHardware for modem dependant settings
  - Return leave KISS mode (optional)

# KISS TNC Protocol details

## ◆ KISS Frame Layout

- FEND 0xc0 Frame Start
- Command & Data bytes
- FEND 0xc0 Frame End

## ◆ Escaping

- FESC 0xdb Escape
- TFEND 0xdc Transposed Frame End
- TFESC 0xdd Transposed Frame Escape

# APRS<sup>®</sup> Protocol details

- ◆ Uses AX.25 Unnumbered Information Packets (UI)
- ◆ Payload is in Info Field
- ◆ Mic-E encodes part in DST Field
- ◆ Time, Position, Objects
- ◆ Weather and Telemetry Data
- ◆ Symbols, Queries, Responses, Status

# APRS<sup>®</sup> Protocol details

## The AX.25 Frame

All APRS transmissions use AX.25 UI-frames, with 9 fields of data:

### AX.25 UI-FRAME FORMAT

	<i>Flag</i>	<i>Destination Address</i>	<i>Source Address</i>	<i>Digipeater Addresses (0-8)</i>	<i>Control Field (UI)</i>	<i>Protocol ID</i>	<i>INFORMATION FIELD</i>	<i>FCS</i>	<i>Flag</i>
Bytes:	1	7	7	0-56	1	1	1-256	2	1



## APRS Data Type Identifiers

<i>Ident</i>	<i>Data Type</i>
0x1c	Current Mic-E Data (Rev 0 beta)
0x1d	Old Mic-E Data (Rev 0 beta)
!	Position without timestamp (no APRS messaging), or Ultimeter 2000 WX Station
"	<i>[Unused]</i>
#	Peet Bros U-II Weather Station
\$	Raw GPS data or Ultimeter 2000
%	Agrelo DFJr / MicroFinder
&	<i>[Reserved — Map Feature]</i>
'	Old Mic-E Data (but <i>Current</i> data for TM-D700)
(	<i>[Unused]</i>
)	Item
*	Peet Bros U-II Weather Station
+	<i>[Reserved — Shelter data with time]</i>
,	Invalid data or test data
-	<i>[Unused]</i>
.	<i>[Reserved — Space weather]</i>
/	Position with timestamp (no APRS messaging)
0-9	<i>[Do not use]</i>
:	Message
;	Object

<i>Ident</i>	<i>Data Type</i>
<	Station Capabilities
=	Position without timestamp (with APRS messaging)
>	Status
?	Query
@	Position with timestamp (with APRS messaging)
A-S	<i>[Do not use]</i>
T	Telemetry data
U-Z	<i>[Do not use]</i>
[	Maidenhead grid locator beacon (obsolete)
\	<i>[Unused]</i>
]	<i>[Unused]</i>
^	<i>[Unused]</i>
_	Weather Report (without position)
`	Current Mic-E Data ( <i>not used</i> in TM-D700)
a-z	<i>[Do not use]</i>
{	User-Defined APRS packet format
	<i>[Do not use — TNC stream switch character]</i>
}	Third-party traffic
~	<i>[Do not use — TNC stream switch character]</i>

# APRS Symbols (partial)

<b>PRIMARY SYMBOL TABLE</b>			
<b>/</b> \$	<b>GPS xyz</b>	<b>GPS Cnn</b>	<b>Icon</b>
/D	PD_	36	
/E	PE_	37	Eyeball (eye catcher)
/F	PF_	38	
/G	PG_	39	Grid Square (6-character)
/H	PH_	40	Hotel (blue bed icon)
/I	PI_	41	TCP/IP
/J	PJ_	42	
/K	PK_	43	School
/L	PL_	44	
/M	PM_	45	MacAPRS
/N	PN_	46	NTS Station
/O	PO_	47	Balloon (SSID -11)
/P	PP_	48	Police

<b>ALTERNATE SYMBOL TABLE</b>			
<b>\</b> \$	<b>GPS xyz</b>	<b>GPS Enn</b>	<b>Icon</b>
\D	AD_	36	Drizzle
\E	AE_	37	Smoke
\F	AF_	38	Freezing Rain
\G	AG_	39	Snow Shower
\H	AH_	40	Haze
\I	AI_	41	Rain Shower
\J	AJ_	42	Lightning
\K	AK_	43	Kenwood
\L	AL_	44	Lighthouse
\M	AM_	45	
\N	AN_	46	Navigation Buoy
\O	AO_	47	
\P	AP_	48	Parking

# Problems with implementation and use

- ◆ Many TNCs allow users to place data directly into actual packets (akin to directly entering data into a TCP packet)
- ◆ UITRACE, RELAY
- ◆ Bad Digi Paths (contents, too long)
- ◆ Path should be WIDE1-1,WIDE2-2
- ◆ Improper duplicate detection
- ◆ Routing done by SRC and not the Net

# References and additional resources

- ◆ Google APRS
- ◆ <http://www.tapr.org/aprs.html>
- ◆ <https://www.tapr.org/cgi-bin/mailman/listinfo/aprssi>
- ◆ <https://lists.tapr.org/cgi-bin/mailman/listinfo/ax25-layer2>
- ◆ [http://www.tapr.org/pub\\_ax25.html](http://www.tapr.org/pub_ax25.html)
- ◆ <http://en.wikipedia.org/wiki/X.25>
- ◆ <http://www.ax25.net/kiss.aspx>

# References and additional resources

- ◆ [http://en.wikipedia.org/wiki/Automatic\\_Position\\_Reporting\\_System](http://en.wikipedia.org/wiki/Automatic_Position_Reporting_System)
- ◆ <http://www.aprs.org/doc/APRS101.PDF>
- ◆ <http://www.aprs.org/aprs11.html>
- ◆ <http://www.aprs.org/aprs12.html>
- ◆ <http://groups.yahoo.com/search?query=aprs>

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