PROPOSAL: RECOMMENDATION AX.224, CLASS 1

# TRANSPORT PROTOCOL SPECIFICATION FOR THE AMATEUR RADIO NETWORK

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## Introduction

The amateur packet network provides a reliable service in that it is relatively free from undetected bit errors. It does, however, have a relatively high rate of lost connections. This problem can be resolved through the implementation of a TRANSPORT PROTOCOL. This is not to suggest that all applications require a TRANSPORT PROTOCOL. In situations where end-to-end data and connection integrity are important, one must use a TRANSPORT PROTOCOL to provide error control.

Recognizing that there are many options available to the community, we the RADIO AMATEUR TELECOMMUNICATIONS SOCIETY, felt that there had to be a single defined protocol available to the broadest possible user base. To achieve this we examined several protocols and determined that the one most appropriate for amateur service was CCITT Recommendation X.224, Class 1. This protocol was chosen for its applicability, simplicity, expandability, and international acceptance.

It is hereby proposed by the members of the RADIO AMATEUR TELECOMMUNICATIONS SOCIETY that this basic subset of CCITT Recommendation X.224 be adopted by the amateur packet community as the preferred transport protocol.

## 1. SCOPE

1.1 The protocol will detect lost packets not detected by the Network Layer and institute required error recovery.

1.2 The protocol will detect the loss of the underlying network connection and institute required error recovery.

## 2. DEFINITIONS

### Data Units

TSDU - Transport Service Data Unit
This is the basic data unit which requires transmission and acknowledgement. Each TSDU may be segmented into many DT-TPDUs and sent across the network.

TPDU - Transport Protocol Data Unit
This is the fundamental unit that is used to convey control information and data between TS-users. TPDUs may not exceed the maximum NSDU length provided by the network.

NSDU - Nework Service Data Unit
This is the data unit used by the underlying network to transmit information.

TPDU Types

CR - Connection Request
CC - Connection Confirm
DR - Disconnect Request
DC - Disconnect Confirm
DT - Data
AK - Data Acknowledge
RJ - Reject
ER - Error

Other

LI - Length Indicator
CDT - Credit
TSAP-ID - Transport Service Access Point Identifier
DST-REF - Destination Reference
SRC-REF - Source Reference
EOT - End of TSDU Mark
TPDU-NR - DT TPDU Number
TSAP - Transport Service Access Point

## 3. TRANSPORT LAYER FUNCTIONS

### 3.1 Connection Establishment

The purpose of connection establishment is to establish a transport connection between two transport service (TS) users. The CR-TPDU is sent by the originating TS-user and the request is confirmed by the reply of a CC-TPDU from the correspondent TS-user.

If the connection is not possible, a DR-TPDU may be sent in reply to the CR-TPDU. The originating TS-user would then confirm this rejection by the transmission of a DC-TPDU.

References are under local control, but in order to ensure that data is properly handled by the TS-provider, they should not be re-used until the list is exhausted. In the event of a network failure that prevents reassignment of the transport connection, the references should be frozen for an extended period. The exact duration is a local issue.

During the establishment phase certain parameters may be conveyed and negotiated with the correspondent TS-user. These parameters are outlined in section 6.

### 3.2 Data Transfer

The data transfer phase permits the TS-users the use of a full-duplex transmission path. The DT-TPDU is used to convey TS-user data across the network. A single TSDU may be segmented into several DT-TPDUs. All TSDUs or DT-TPDU sequences are explicitly acknowledged through the use of the AK-TPDU. A DT-TPDU sequence is completed through the setting of the EOT-bit in the last DT-TPDU.

### 3.3 Release

The connection release phase allows for the disconnection of a transport connection. It is signalled by the transmission of a DR-TPDU and confirmed by the reception of a DC-TPDU from the correspondent TS-user.

### 3.4 Resynchronization

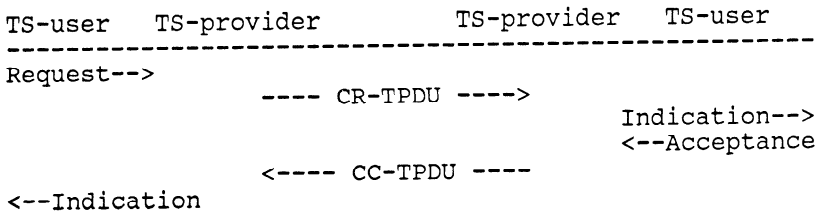
If a TDPU in a DT-TPDU sequence is lost due to network reset or error, the receiving TS-user will reply with the transmission of a RJ-TPDU. This RJ-TPDU will provide the correspondent TS-user with an indication of which DT-TPDU was lost.

### 3.5 Reassignment

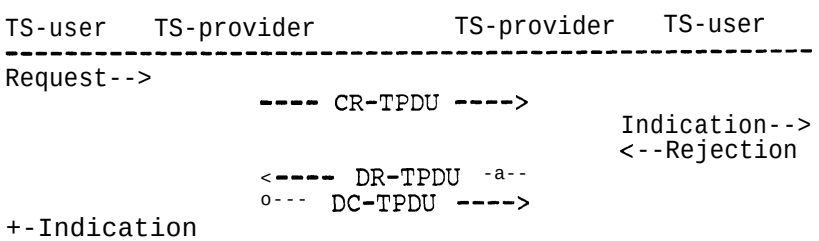
This capability allows a transport connection to recover from a signalled disconnect in the underlying network service. When this occurs, the TTR timer should be started and the transport connection should be reassigned to a new network connection. If TTR expires, the reference should be frozen and the transport connection should be released.

## 4. TRANSPORT LAYER PROCEDURES

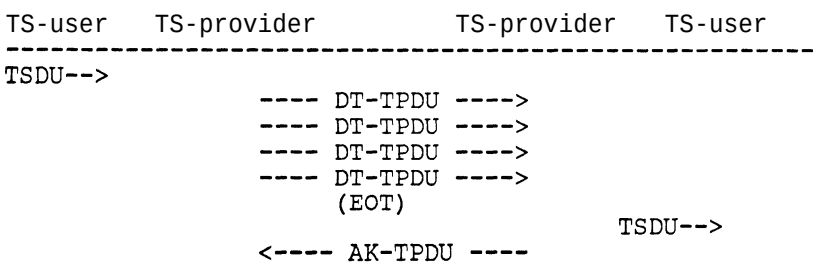
### 4.1 Connection Establishment



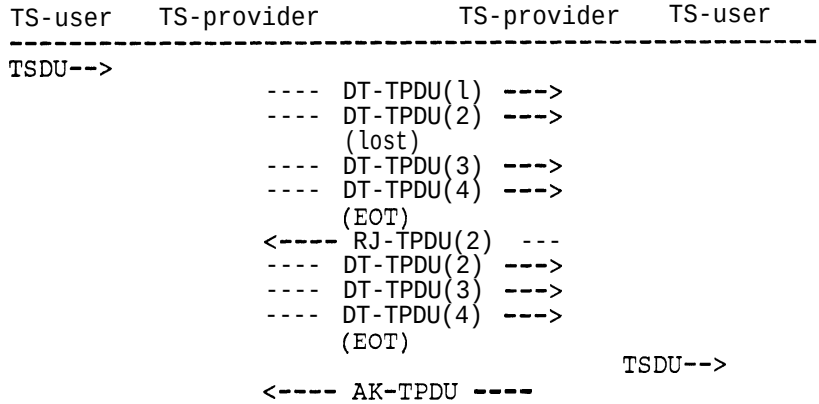

### 4.2 Connection Rejection



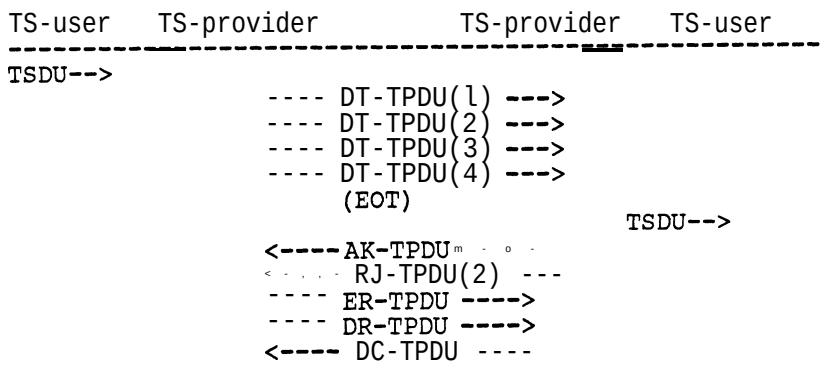

### 4.3 Data Transfer



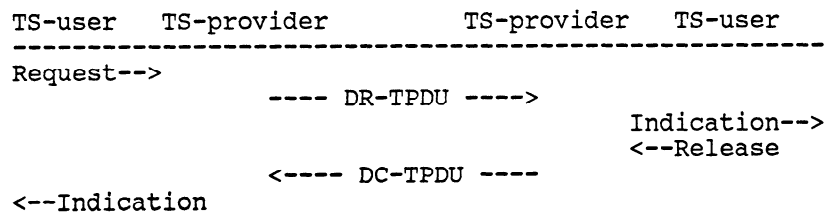

### 4.4 Reject



4.5 Protocol Error




4.6 Connection Release (normal)




5. STRUCTURE AND CODING OF TPDUs

5.1 Validity

Table 5/AX.224 specifies those TPDU's which are valid for class 1 and the code for each TPDU.

TABLE 5/AX.224

| | | | |
|---|---|---|---|
| CR | Connection Request | **11100000** | **5.3** |
| cc | Connection Confirm | **11010000** | **5.4** |
| DR | Disconnect Request | **10000000** | **5.5** |
| DC | Disconnect Confirm | **11000000** | **5.6** |
| DT | Data | **11110000** | **5.7** |
| AK | Data Acknowledge | **01101111** | **5.8** |
| RJ | Reject | **01011111** | **5.9** |
| ER | TPDU Error | **01110000** | **5.10** |

5.2 Structure

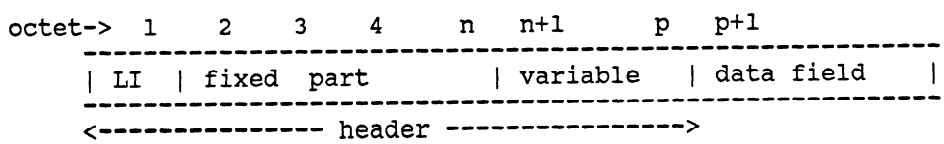
All the TPDU's shall contain an integral number of octets. The octets in a TPDU are numbered starting from 1 and increasing in the order they are in into the Network Service Data Unit (NSDU). The bits in an octet are numbered from 1 to 8, where bit 1 is the low-order bit.

When consecutive octets are used to represent a binary number or a binary coded decimal number (one digit per octet), the lower number octet has the most significant value.

TPDUs shall contain, in the following order:

a) the header, comprising:
   1) the length indicator (LI) field:
   2) the fixed part:
   3) the variable part, if present:
b) the data field, if present.

This structure is illustrated below



### 5.2.1 Length Indicator Field

This field is contained in the first octet of the TPDU's. The length is indicated by a binary number, with a maximum value of 254 (1111 1110). The length indicated shall be the header length in octets including parameters, but excluding the length indicator field and user data, if any. The value 255 (1111 1111) is reserved for possible extensions.

If the length indicated exceeds the size of the underlying NSDU this is a protocol error.

### 5.2.2 Fixed Part

The fixed part contains frequently occurring parameters including the code of the TPDU. The length and the structure of the fixed part are defined by the TPDU code.

If any of the parameters of the fixed part have an invalid value, or if the fixed part cannot be contained within the header (as defined by LI) this is a protocol error.

### 5.2.3 Variable Part

The variable part is used to define less frequently used parameters. If the variable part is present, it shall contain one or more parameters.

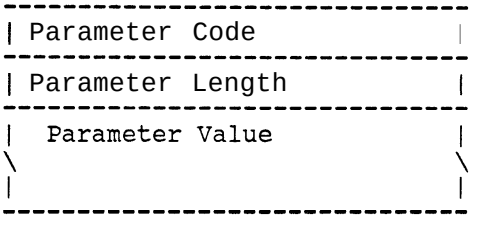
The parameter code field is coded in binary.

The parameter length is limited to 248. In the case of a single parameter contained within the variable part, two octets are required for the parameter code and the parameter length indication itself. For larger fixed parts of of the header and for each succeeding parameter the maximum value decreases.

The parameters defined in the variable part may be in any order.

An invalid parameter will be treated as a protocol error.

Each parameter contained within the variable part is structured xas follows:

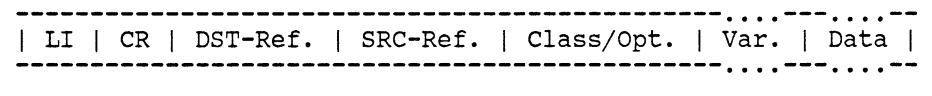



### 5.2.4 Data Field

This field contains transparent user data. Restrictions on its size are noted for each TPDU.

## 5.3 Connection Request - CR

The length shall not exceed 128 octets.




CR is set to 11100000B.

The Destination Reference (DST-Ref.) is coded as 0000H.

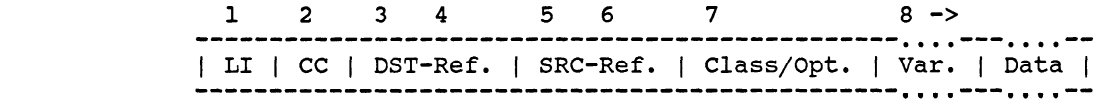
The Source Reference (SRC-Ref.) is selected by the initiating transport entity.

The Class/Options octet is set to 00010000B.

The variable part contains parameters defined in section 6.

The CR may contain up to 32 octets of user data.

## 5.4 Connection Confirm - CC




CC is set to 11010000B.

The Destination Reference (DST-Ref.) is selected by the remote transport entity.

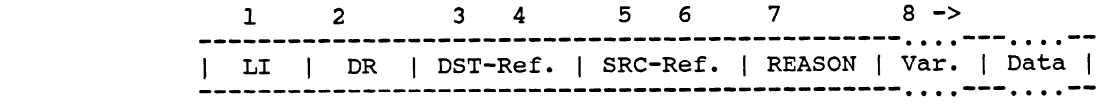
The Source Reference (SRC-Ref.) is selected by the initiating transport entity.

The Class/Options octet is set to 00010000B.

The variable part contains parameters defined in section 6.

The CR may contain up to 32 octets of user data.

## 5.5 Disconnect Request - DR




DR is set to 10000000B.

The Destination Reference (DST-Ref.) is selected by the remote transport entity.

The Source Reference (SRC-Ref.) is selected by the initiating transport entity.

The Reason code is the reason for disconnection. The values include:

| | |
|---|---|
| 128 + 0 | Normal Disconnect |
| 128 + 1 | Congestion at Connect Request Time |
| 128 + 2 | Connection Negotiation Failed |
| 128 + 3 | Duplicate Connection Detected |
| 128 + 4 | Mismatched References |
| 128 + 5 | Protocol Error |
| 128 + 6 | Not Used |
| 128 + 7 | Reference Overflow |
| 128 + 8 | Connection Request On This Network Connection |
| 128 + 9 | Not Used |
| 128 + 10 | Header or Parameter Length Invalid |

Additional codes include:

| | |
|---|---|
| 0 | Reason Not Specified |
| 1 | Congestion TSAP |
| 2 | Session Entity Not Attached to TSAP |
| 3 | Address Unknown |

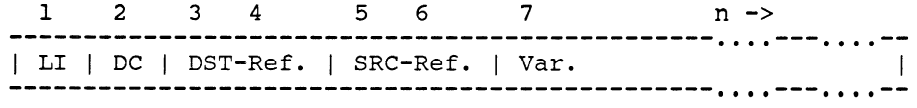
The variable part may contain a parameter with additional information related to the clearing of the connection.

The Parameter Code Value is 11100000B

The parameter length may be any value provided that the DR-TPDU length does not exceed the maximum agreed TPDU size or 128 when the DR-TPDU is used during the connection rejection procedure.

The DR may contain up to 32 octets of user data.

## 5.6 Disconnect Confirm - DC

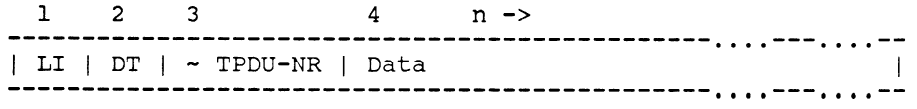



DC is set to 11000000B.

The Destination Reference (DST-Ref.) is selected by the remote transport entity.

The Source Reference (SRC-Ref.) is selected by the initiating transport entity.

## 5.7 Data - DT



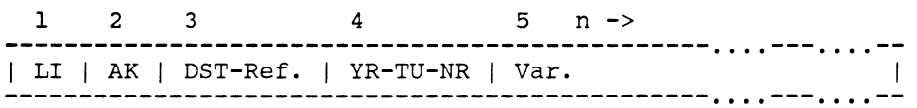

DT is set to 11110000B.

~ The EOT bit, when set to one, signals that this DT-TPDU is the last in a sequence carry a TSDU. This bit is bit 8 of octet 3.

TPDU-NR is the TPDU Send Sequence Number. The TPDU-NR uses bits 7-1 in octet 3.

The data field may contain up to the negotiated TPDU size minus 3 octets. (Header overhead)

## 5.8 Data Acknowledge - AK

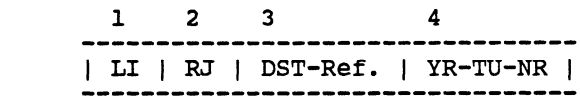



AK is set to 01101111B

The Destination Reference (DST-Ref.) is selected by the remote transport entity.

The YR-TU-NR ) is the sequence number indicating the next expected DT-TPDU number. Bits 7-1 shall indicate this value. Bit 8 is not used and shall be set to 0.

5.9 Reject - RJ

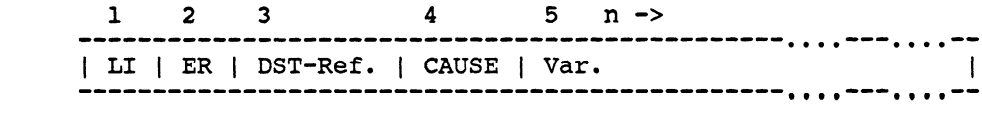



RJ is set to 01011111B

The Destination Reference (DST-Ref.) is selected by the remote transport entity.

The YR-TU-NR ) is the sequence number indicating the next expected DT-TPDU number from which retransmission should occur. Bits 7-l shall indicate this value. Bit 8 is not used and shall be set to 0.

5.10 Error - ER




ER is set to 01110000B

The Destination Reference (DST-Ref.) is selected by the remote transport entity.

Reject Cause:

0 Not Specified
1 Invalid Parameter Code
2 Invalid TPDU Type
3 Invalid Parameter Value

The variable field contains the Invalid TPDU parameter.

The parameter code is 11000001B.

The parameter length is the number of octets in the value field.

The parameter value contains the bits pattern of the rejected TPDU header up to and including the octet which caused the rejection.

6. CONNECTION ESTABLISHMENT PARAMETERS

The connection establishment parameters allow the TS-user to select operational characteristics required for the support of the connection. These parameters provide the underlying network service provider with an indication of what facilities are required by this user. These paramters are outlined below.

6.1 TPDU Size

Parameter Code: 11000000B

Parameter Length: 1 octet

Parameter Value:

ODH 8192 octets
OCH 4096 octets
OBH 2048 octets
OAH 1024 octets
09H 512 octets
08H 256 octets
07H 128 octets

Default value: 07H (128 octets)

6.2 Version Number

Parameter Code: 11000100B

Parameter Length: 1 octet

Parameter Value: 00000001B

Default value: 00000001B

6.3 Security Parameters

Parameter Code: 11000101

Parameter Length: user defined

Parameter Value: user defined

6.4 Additional Option Selection

Parameter Code: 11000110

Parameter Length: 1 octet

Parameter Value: 00000000B

Use of this parameter is mandatory.

6.5 Throughput

Parameter Code: 10001001

Parameter Length: 12 or 24 octets

Parameter Value:

1st 12 octets: maximum throughput, as follows:

- 1st 3 octets: target value, calling-called user direction;
- 2nd 3 octets: minimum acceptable, calling-called user direction:
- 3rd 3 octets: target value, called-calling user direction;
- 4th 3 octets: minimum acceptable, called-calling user direction.

2nd 12 octets: average throughput, as follows:

- 5th 3 octets: target value, calling-called user direction;
- 6th 3 octets: minimum acceptable, calling-called user direction;
- 7th 3 octets: target value, called-calling user direction:
- 8th 3 octets: minimum acceptable, called-calling user direction.

Where the average throughput is omitted, it is considered to have the same value as the maximum throughput.

Values are expressed in octets per second.

6.6 Residual Error Rate

Parameter Code: 10000110B

Parameter Length: 3 octets

Parameter Value:

1st octet: Target Value, power of 10
2nd octet: Minimum Acceptable, power of 10
3rd octet: TSDU size of interest, expressed as a power of 2.

6.7 Priority

Parameter Code: 10000111B

Parameter Length: 2 octets

Parameter Value: Integer (High = 0)

6.8 Transit Delay

Parameter Code: 10001000

Parameter Length: 8 octets

Parameter Value:

1st 2 octets: target value, calling-called user direction:
2nd 2 octets: minimum acceptable, calling-called user direction:
3rd 2 octets: target value, called-calling user direction;
4th 2 octets: minimum acceptable, called-calling user direction.

Values are expressed in miliseconds, and are based upon a TSDU size of 128 octets.

6.9 Reassignment Time

This parameter conveys the Time to Try Reassignment / Resynchronization (TTR) which will be used when following the procedure for Reassignment after Failure.

Parameter Code: 10001011

Parameter Length: 2

Parameter Value: n, a binary number, where n is the TTR value expressed in seconds.