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Data Service Options for Spread Spectrum Systems: Async Data and Fax Services

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TABLES

1 INTRODUCTION

1.1 General Description

Service Options 4, 4100 and 12 provide asynchronous (abbreviated as “async” hereafter) data transmission capability on CDMA2000® [1] wideband spread spectrum systems using the protocols and procedures defined herein. Service Options 5, 4101 and 13 provide Group-3 facsimile (abbreviated as “fax” hereafter) transmission capability for these systems.

Service Options 4, 5, 4100 and 4101 provide async data and group 3 fax service using a default service configuration including Multiplex Option 1 data rates. Service Options 12 and 13 provide async data and group 3 fax service using a default service configuration including Multiplex Option 2 data rates. Other combinations of service configuration attributes are available for service options 4, 5, 4100, 4101, 12, and 13 through the use of service negotiation procedures.

1.2 Terms

AT Command Set. Command set interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE).

Base Station (BS). A station in the Domestic Public Cellular Radio Telecommunications Service, other than a mobile station, used for communicating with mobile stations. Depending upon the context, the term base station may refer to a cell, a sector within a cell, or other part of the cellular system.

BS. See base station.

BS/MSC. The base station and mobile switching center considered as a single functional entity.

Data Circuit-Terminating Equipment (DCE). A DCE connects a TE2 to the PSTN. A typical DCE would be a V-series modem. For Group-3 Fax Service, the DCE and its associated TE2 are often combined into a single Group-3 fax machine.

Digital Facsimile. That form of facsimile in which densities of the original are sampled and quantified as a digital signal for processing, transmission, or storage.

Error Correction Mode (ECM). A mode of operation for T.30 fax service providing end-to-end reliable data transport.

Facsimile. The process by which a document is scanned, converted into the electrical signals, transmitted, and recorded or displayed as a copy of the original.

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[1] CDMA2000® is the trademark for the technical nomenclature for certain specifications and standards of the Organizational Partners (OPs) of 3GPP2. Geographically (and as of the date of publication), CDMA2000® is a registered trademark of the Telecommunications Industry Association (TIA-USA) in the United States.

Fax. An abbreviation for facsimile.

Fax Calling Station. The fax machine or fax modem initiating the fax call.

Group-3. Digital Facsimile equipment per CCITT Recommendation T.4.

ICMP. Internet Control Message Protocol.

IANA. Internet Assigned Number Authority.

Interworking Function (IWF). An IWF provides the functions needed for terminal equipment connected to a mobile termination to communicate with terminal equipment connected to the PSTN. A physical implementation may include a pool of modems.

IP. Internet Protocol.

IPCP. Internet Protocol Control Protocol.

L. L-Interface. The interface between an IWF and BS/MSC.

LCP. PPP Link Control Protocol.

Mobile Station. A station in the Domestic Public Cellular Radio Telecommunications Service intended to be used while in motion or during halts at unspecified points. Mobile stations include portable units (e.g., hand-held personal units) and units installed in vehicles.

Mobile Termination 0 (MT0). An MT0 is a self-contained data-capable mobile termination that does not support an external interface.

Mobile Termination 2 (MT2). An MT2 provides a non-ISDN (R_m) user interface, e.g., CCITT V series or CCITT X series.

Modem Client. The name given to the TCP well-known port used for CDMA async data and fax services in mobile stations.

Modem Server. The name given to the TCP well-known port used for CDMA async data and fax services in a BS/MSC.

Modem Emulation Service. A wireless data service where the mobile termination appears as a standard telephone modem to a data terminal.

MSC. Mobile Switching Center.

PPP. Point-to-Point Protocol.

PSTN. Public Switched Telephone Network.

RFC. Request for Comments. The generic name of a standard developed by the Internet Engineering Task Force (IETF).

RLP. Radio Link Protocol.

SNDCF. Sub-Network Dependent Convergence Function.

TCP. Transmission Control Protocol.

Terminal Equipment 2 (TE2). A TE2 is a data terminal device that has a non-ISDN user-network interface, e.g., CCITT V series or CCITT X series.

1.3 References

The following standards and 3GPP2 specifications contain provisions that, through reference in this text, constitute provisions to this document. All referenced publications are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the works indicated below. ANSI and TIA maintain registers of currently valid national standards published by them.

3GPP2 Specifications and SDO Standards

1.	Reserved	
2.	3GPP2: C.S0002-C v1.0 ARIB: CWTS: TIA: TIA/EIA/IS-2000.2-C TTA: TTC:	Physical Layer Standard for cdma2000 Spread Spectrum Systems – Release C
3.	3GPP2: C.S0003-C v1.0 ARIB: CWTS: TIA: TIA/EIA/IS-2000.3-C TTA: TTC:	Medium Access Control (MAC) for cdma2000 Spread Spectrum Systems – Release C
4.	3GPP2: C.S0004-C v1.0 ARIB: CWTS: TIA: TIA/EIA/IS-2000.4-C TTA: TTC:	Signaling Link Access Control (LAC) for cdma2000 Spread Spectrum Systems – Release C
5.	3GPP2: C.S0005-C v1.0 ARIB: CWTS: TIA: TIA/EIA/IS-2000.5-C TTA: TTC:	Upper Layer (Layer 3) Signaling for cdma2000 Spread Spectrum Systems – Release C
6.	Reserved	
7.	3GPP2: C.S0017.2-0 v1.0 ARIB: CWTS: TIA: TIA/EIA/IS-707.2-A TTA: TTC:	Data Service Options for Spread Spectrum Systems: Radio Link Protocol

8.	3GPP2: C.S0017-003-A ARIB: CWTS: TIA: TIA-707.03-B TTA: TTC:	Data Service Options for Spread Spectrum Systems: AT Command Processing and the Rm Interface

ANSI X3.4-1986	*Coded Character Set – 7-Bit American National Standard Code for Information Interchange, 1992.*
Bell 103	*0-300 bps, 2-wire, full-duplex modem standard.*
Bell 212A	*1200 bps, 2-wire, full-duplex modem standard.*
EIA/TIA-232-E	*Interface Between DTE and DCE Employing Serial Binary Data Interchange.*
EIA/TIA-592	*Asynchronous Facsimile DCE control Standard - Service Class 2.0.*
EIA/TIA-602	*Serial Asynchronous Automatic Dialing and Control.*
EIA/TIA-605	*Facsimile DCE-DTE Packet Protocol Standard.*
EIA/TIA-615	*Extensions to Serial Asynchronous Automatic Dialing and Control.*
RFC 791	*Internet Protocol.*
RFC 792	*Internet Control Message Protocol.*
RFC 793	*Transmission Control Protocol.*
RFC 854	*Telnet Protocol Specification.*
RFC 855	*Telnet Options Specification.*
RFC 950	*Internet Standard Subnetting Procedure.*
RFC 1112	*Host Extensions for IP Multicasting.*
RFC 1122	*Requirements for Internet Hosts – Communication Layers.*
RFC 1123	*Requirements for Internet Hosts – Application and Support.*
RFC 1144	*Compressing TCP/IP Headers for Low-Speed Serial Links.*
RFC 1166	*Internet Numbers.*
RFC 1191	*Path MTU Discovery.*
RFC 1332	*The PPP Internet Protocol Control Protocol (IPCP).*
RFC 1349	*Type of Service in the Internet Protocol Suite.*
RFC 1570	*PPP LCP Extensions.*
RFC 1661	*The Point-to-Point Protocol (PPP).*
RFC 1662	*PPP in HDLC Framing.*

RFC 1700	*Assigned Numbers* (most recent version).
T.4	*Compression*/decompression standard for facsimile applications.
T.30	*Facsimile* protocol standard.
ANSI/TIA/EIA-617	*Inband DCE Control for Asynchronous DTE–DCE Interfaces*.
TIA/EIA/IS-131	*Data Transmission Systems and Equipment – Extensions to Serial Asynchronous Dialing and Control*.
TIA/EIA/IS-134	*Amendments to TIA-592 to Support T.30-1993*.
TSB58	*Administration of Parameter Value Assignments for TIA/EIA Wideband Spread Spectrum Standards. (Informative)*
V.17	14,400 bps, 2 wire, half duplex modem standard.
V.18	*Operational and Interworking Requirements for Modems Operating in the Text Telephone Mode,* International Telecommunications Union, 1994.
V.21	300 bps, 2 wire, full-duplex modem standard.
V.22	1200/*600* bps, 2 wire, full-duplex modem standard.
V.22*bis*	2400 bps, 2 wire, full duplex modem standard.
V.27*ter*	*4800*/2400 bps, 2 wire, half-duplex modem standard.
V.29	*9600* bps, 2 wire, full duplex modem standard.
V.32	*9600* bps, 2 wire, full duplex modem standard.
V.32*bis*	14,*400* bps 2 wire, full duplex modem standard.
V.34	Full duplex modem standard up to 28,800 bps.
V.42	*Error-correction procedures for DCEs using asynchronous to synchronous conversion*.
V.42*bis*	*Data compression procedures for DCEs using error correction procedures*.

No text.

2 REQUIREMENTS FOR THE ASYNC DATA AND FAX PROTOCOL STACK

2.1 Overview

This chapter specifies requirements for an asynchronous data and group 3 facsimile service for CDMA wireless systems based on the protocol stack reference architecture shown in Figure 2.1-1. The service is designed to provide modem emulation functions over a wireless data link to a TE2. Although actual implementations may vary with respect to specific network elements, functionality available over the air (U_m) interface shall be in accordance with the requirements specified in this standard.

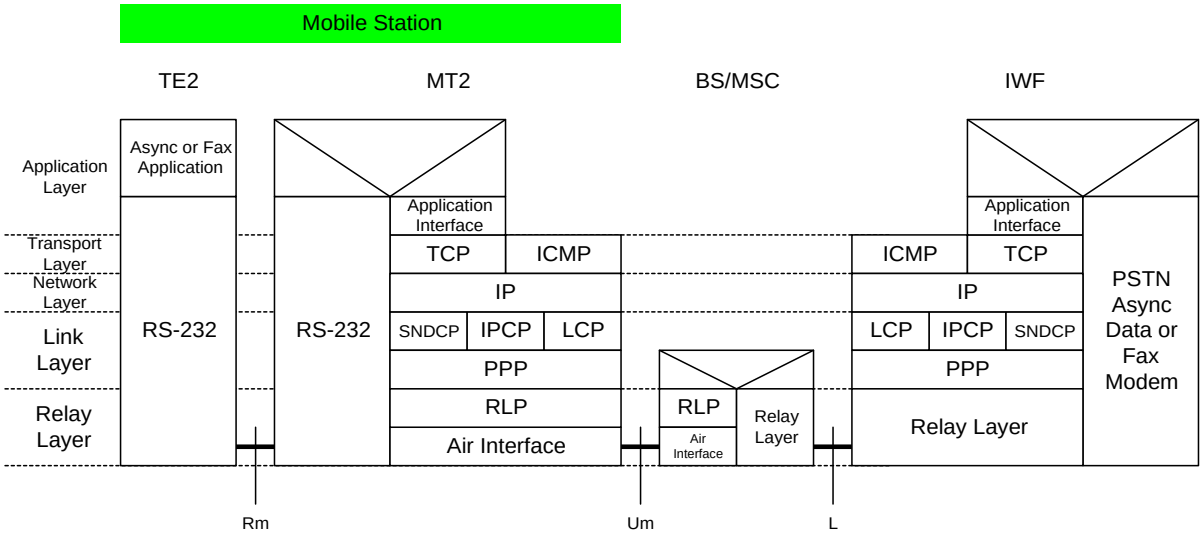

Figure 2-1. The Async Data and Fax Protocol Stack Architecture

The Application Layer consists of an async data or fax user application on a TE2, and the associated application interfaces in the MT2 and in the IWF. The application interfaces in the MT2 and in the IWF support EIA/TIA standardized modem control commands, and together provide an interface compatible with those encountered in practical modem implementations.

The Transport Layer consists of Transmission Control Protocol (TCP). TCP (See RFC 793) provides a reliable transport service to all application layer and user data exchanges.

The Network Layer consists of ICMP, (see RFC 792) and IP (see RFC 791) protocols to provide network layer transport of modem control and user data over the CDMA air interface.

The Link Layer consists of Point to Point Protocol (PPP), Link Control Protocol (LCP), and Internet Protocol Control Protocol (IPCP). PPP (see RFC 1661 and 1662) provides a multiplexed method to carry higher layer protocol data over serial links. LCP (see RFC 1570) provides a mechanism for the Mobile Station and the IWF to negotiate various options provided by PPP. IPCP (see RFC 1332) allows the Mobile Station request a temporary IP address from the IWF.

The Relay Layer consists of physical and logical interface functions required to support the link, network, transport and application layers described above. Central to the relay layer is the inclusion of a Radio Link Protocol (RLP) (see [7]) to improve the error characteristics of the wireless link, thereby reducing the need for Transport Layer retransmissions due to lost data.

The protocol stack, as specified in this standard, describes a minimal subset of the TCP, IP and PPP protocols for the mobile station. BS/MSC and IWF protocol implementations shall be compatible with mobile stations having the minimal implementation specified herein.

2.2 The Application Interface

In the mobile station, CDMA async data and fax services shall include an application interface between the data source/destination in the MT0 or TE2 and the transport protocol layer.

In the IWF, the application interface shall reside between the PSTN Data or Fax modem and the transport protocol layer.

The application interface shall provide the following functionality:

- Modem control, as specified in 4 of [8].
- AT Command processing, as defined in [8].
- Negotiation of air interface data compression.
- Data compression over the air interface (optional).

In a mobile station, data entering the application interface from the R_m interface shall first be parsed to extract locally processed time dependent modem control commands and the associated escape characters. These commands shall be processed in accordance with [8]. The resulting data shall be parsed to extract locally processed AT commands (see [8]). ANSI/TIA/EIA-617 in-band commands shall then be inserted, including any necessary escaping, as described in ANSI/TIA/EIA-617. Option negotiation commands shall then be inserted, including any necessary escaping, as described below. The resulting data shall be passed to the transport layer.

In a mobile station, data entering the application interface from the transport layer shall first be parsed to extract the option negotiation commands and the associated escaping. The resulting data shall be parsed to extract locally processed ANSI/TIA/EIA-617 in-band commands (see [8]). The resulting data shall be passed to the R_m interface.

In the IWF, data entering the application interface from the PSTN data or fax modem shall be passed to the transport layer. ANSI/TIA/EIA-617 in-band commands shall then be inserted, including any necessary escaping, as described in ANSI/TIA/EIA-617. Option negotiation commands shall then be inserted, including any necessary escaping, as described below.

In the IWF, data entering the application interface from the transport layer shall first be parsed to extract the option negotiation commands and the associated escaping. The resulting data shall be parsed to extract any ANSI/TIA/EIA-617 in band modem control commands (see [8]). If the IWF application interface is in command state or online

command state, the resulting data shall be parsed to extract any AT commands (see [8]). The resulting data shall be passed to the PSTN data or fax modem.

The application interface for CDMA async data and fax services shall comply with the requirements of Sections 2.3 and 2.4 of RFC 1123, with the following modifications:

- An IWF serving multiple users may be treated as part of a single multi-homed host or as independent hosts.
- The mobile station application interface should specify type of service as described in RFC 1349. The mobile station and the IWF should specify the types of service shown in Table 2.2-1.

Table 2-1. IP Type of Service

Service Option	Type of Service
4, 4100, 12 (Async Data)	Low delay
5, 4101, 13 (Group-3 Fax)	Max throughput

For mobile-originated data calls, the mobile station application interface shall open the transport layer using TCP well-known port 380 (“modem server”) as the destination port. For mobile-terminated data calls, the IWF application layer shall open the transport layer using TCP well-known port 379 (“modem client”) as the destination port.

The application interface in the mobile station and the IWF should also support data compression, using the following negotiation protocol.[2]

To ensure transparency of user data to compression negotiation commands, the sender shall insert an additional octet of value 255 before each data byte of value 255, except for IAC octets that are part of negotiation commands. The receiver shall remove the inserted octets of value 255 and any negotiation commands after decompression.

[2] This protocol is based on the Telnet option negotiation protocol, as described in Internet RFC 854. This use of Telnet negotiation does not prevent the use of Telnet applications by means of the CDMA async data service, since the negotiation in the CDMA async data application protocol layer is transparent to the user application, including a user’s Telnet session.

The application interface shall support option negotiation commands in accordance with the requirements of RFC 854, except that only the following commands are required:

NAME	CODE	MEANING
SE	240	End of subnegotiation parameters.
SB (option code)	250	Indicates that what follows is subnegotiation of the indicated option.
WILL (option code)	251	Indicates a desire to begin performing the indicated option.
WON'T (option code)	252	Indicates a refusal to perform, or continue performing, the indicated option.
DO (option code)	253	Indicates a request that the other station begin performing the indicated option.
DON'T (option code)	254	Indicates a demand that the other station stop performing the indicated option.
IAC	255	Interpret as Command.

The data compression option shall be indicated by setting the option code to the value shown in Table 2.2-2 for the type of data compression being negotiated.[3] Data compression parameters shall be negotiated using the procedure described in RFC 855, and further defined below.

If data compression is supported by the IWF, the IWF shall initiate negotiation of data compression by sending a WILL command when the transport layer connection is opened. The mobile station shall respond with a DO or DON'T command.

The mobile station shall not initiate negotiation of data compression.

If the mobile station responds with a DO command, the IWF shall transmit a subnegotiation (SB) command followed by the requested data compression control parameters. The mobile station shall respond with a subnegotiation (SB) command with either the same parameters, an alternative set, or a DON'T command.

If the mobile station replies with an SB command whose parameters are acceptable to the IWF, the IWF shall send a DO command. If the accepted subnegotiation parameters include a request for forward link compression, the IWF shall compress all applicable data following the DO command. The mobile station shall respond to the DO command with a WILL command. The negotiation process is terminated when the IWF receives the WILL command. If the accepted subnegotiation parameters include a request for reverse link

[3] These option numbers may overlap Telnet option number assignments. There is no conflict because compression negotiation is hidden from any Telnet application that makes use of the CDMA async data service.

compression, the mobile station shall compress all applicable data following the WILL command.

Compression shall be applicable only as follows:

- For Service Options 4, 4100 and 12 (async data), if V.42*bis* is employed data passed from the application interface to the transport layer, in the negotiated directions following the DO or WILL command, shall be compressed. Compression may be enabled independently in each direction.
- For Service Options 5, 4101 and 13 (group 3 facsimile), if MMR compression (see CCITT T.4) is used, it shall only be applied to the actual fax image data being transmitted. If MMR compression is negotiated during transmission of a page, the compression shall be enabled for subsequent pages. If V.42*bis* is used, compression shall begin immediately following the DO or WILL command. V.42*bis* compression may be enabled independently in each direction.

If the mobile station replies with an SB command containing parameters not acceptable to the IWF, the IWF shall send a DON'T command. The IWF may re-initiate negotiation at any time.

Either side may terminate compression or subnegotiation at any time by sending a DON'T command and shall send uncompressed data following the command. Whenever a DON'T command is received, the receiver shall respond with a WON'T command and shall send uncompressed data following the command. When possible, the timing of these commands relative to the decompression process should be chosen to minimize loss of data. If V.42*bis* compression is negotiated, it shall not be disabled for the duration of the call.

Subnegotiation parameters shall be transmitted in the following format. If any octet following the OPTION octet and preceding the next IAC octet has value 255, an additional octet of value 255 shall be inserted. The value of the PARAMETER_LEN field shall not change as the result of such insertion. The receiver shall remove all such inserted octets prior to processing the subnegotiation parameters.

Field Name	Size (octets)
IAC	1
SB	1
OPTION	1

Zero or more occurrences of the following entry:

PARAMETER_ID	1
PARAMETER_LEN	1
PARAMETER_VAL	PARAMETER_LEN

The subnegotiation parameter list shall be followed immediately with:

IAC	1
SE	1

OPTION - Option value. The application interface shall set this field to the value shown in Table 2.2-2 corresponding to the type of compression selected.

Table 2-2. Compression Options

Option	Compression Type
0x00	V.42*bis* compression
0x01	Modified Modified Read Coding (Service Option 5, 4101 and 13 only)
All other values are reserved.	

PARAMETER_ID - Parameter Identifier.

The application interface shall set this field to identify the parameter. All parameters in the subnegotiation command shall be as required for the selected compression option.

PARAMETER_LEN - Parameter Length.

The application interface shall set this field to the number of octets in this parameter, not including the PARAMETER_ID and PARAMETER_LEN fields.

PARAMETER_VAL - Parameter Value. Indicates the desired setting for this parameter.

If negotiation does not occur, the default setting shall apply. For the async data and group 3 fax service options the default setting is no compression.

If the OPTION field selects V.42*bis* compression, the parameter entries may be configuration parameters 1, 2 and/or 3 of the compression scheme defined in CCITT Recommendation V.42*bis*. For V.42*bis* compression, these parameters, their identifiers, and lengths, are as defined in V.42*bis*, Annex A. For negotiation of V.42*bis* compression, the IWF is always considered the initiator.

For each direction of transmission for which V.42*bis* compression is requested, the compression scheme defined in CCITT Recommendation V.42*bis* shall be applied to all data passed from the application interface to the transport layer, and the corresponding decompression scheme shall be applied to all data passed from the transport layer to the application interface.

If the OPTION field selects Modified Modified Read Coding compression, no parameter entries are defined.

When a Group 3 fax service option is connected, and MMR or V.42*bis* compression is negotiated, it shall only be used in accordance with Table 2.2-3.

Table 2-3. Group 3 Fax Compression Options

PSTN Compression Method	U_m Compression Method
Modified Huffman	Modified Modified Read or V.42*bis*
Modified Read	(no additional compression)
Modified Modified Read	(no additional compression)

If Modified Modified Read compression is negotiated, the compression scheme defined in CCITT Recommendation T.4 shall be applied only to the fax image data passed from the data source to the application interface layer, and the corresponding decompression scheme shall be applied only to the fax image data passed from the application interface layer to the data destination.

2.3 Transport Layer

The transport layer for CDMA async data and fax services is based on the Internet transport layer protocol known as Transmission Control Protocol (TCP), described in RFC 793.

The implementation shall comply with the requirements of RFC 793, as amended by RFC 1122, with the following modifications:

- TCP should always advertise a Maximum Segment Size (MSS), which should be no smaller than 536 octets (which is the default value).
- TCP should limit the transmitted segment size to no more than 2047 octets.[4]
- TCP should advertise a window size no smaller than twice the advertised MSS, and no larger than 4 times the MSS.
- For each connection, the transport layer shall use a different source port number than the one used in the previous connection. The port numbers used shall be in the range from 0x1000 (decimal 4096) to 0xffff (decimal 65535), inclusive. The mobile station's port number may be initialized to an arbitrary value in this range on power-up.

[4] This limit is intended to prevent excessive segment error rates under conditions where the RLP frame error rate is high. The TCP MSS option provides a means for restricting the segment size to a smaller value if required by an implementation.

- The IP maximum segment lifetime (Time To Live) shall be set to 0xfe (decimal 254) if it is not configurable. When provision is made for configuration, the initial value should be the number currently in effect as published in Internet "Assigned Numbers."[5]
- Mobile stations shall handle TCP connection failures using the following procedure, unless disabled by the application interface:
  - During initial connection synchronization, the number of retransmission attempts (R2) shall be 5 retransmissions, after which the connection should be closed.
  - After the connection has been established, the default value of R2 shall be either 100 seconds or 10 retransmissions, after which the connection may be closed.[6]

The manufacturer shall provide a means for the application interface to disable this procedure. If this procedure is disabled, there shall be no maximum number of retransmission attempts during synchronization, and an established TCP connection shall remain open until explicitly closed by the mobile station or the IWF. The application interface shall be able to set the value of R2. R2 may be measured in time units or as a count of retransmissions.

IWFs shall follow either the procedure of 4.2.3.5 of RFC 1122, or the procedure above.

2.4 Network Layer

2.4.1 General Requirements

The network layer for CDMA async data and fax services is based on the Internet network layer protocol known as the Internet Protocol (IP), as described in RFC 791.

The network layer shall also include the Internet Control Message Protocol (ICMP), as described in RFC 792.

The implementation shall comply with the requirements of RFC 791 as amended by RFC 1122, with the following modifications:

- The mobile station network layer is not required to support the subnet addressing modes described in RFC 950. The IWF network layer should support subnet addressing as described in RFC 950 and RFC 1122.
- The mobile station network layer may assume that it is locally connected to the IWF.
- Mobile stations shall not perform "Dead Gateway Detection" (see 3.3.1.4 of RFC 1122) nor "New Gateway Selection" (see 3.3.1.5 of RFC 1122) in the network layer.

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[5]The most recently published value is 64, per RFC 1700.

[6]It is recommended that the application keep the connection open, and wait for notification of an improvement in connectivity or link quality before attempting further retransmissions.

- The Address Mask Request and Reply are obsolete, and should not be sent.
- The mobile station is not required to support the Internet Group Management Protocol (IGMP) as described in RFC 1112.
- The network layer shall not fragment IP datagrams for transmission on the U_m interface. If fragmented datagrams that are received from a network cannot be transmitted on the U_m interface after reassembly, they shall be discarded as specified in RFC 1191.
- The mobile station shall support the End of Option list IP option and the No Operation IP option (see RFC 791).

The interface between the network layer and the transport layer shall comply with the requirements of 3.4 of RFC 1122.

2.4.2 Assignment of Network Address

The IWF assigns the mobile station a temporary IP address upon call establishment. This IP address shall be valid and should be uniquely assigned to the mobile station for the duration of the call.[7] The IWF transfers the temporary IP address to the mobile station using IPCP (see 2.5.3).

2.5 Data Link Layer

2.5.1 Sub-Network Dependent Convergence Function

The Sub-Network Dependent Convergence Function (SNDCF) performs header compression on the headers of the transport and network layers. This function is negotiated using the PPP Internet Protocol Control Protocol (see 2.5.3).

Mobile stations shall support Van Jacobson TCP/IP header compression, as described in RFC 1144, "Compressing TCP/IP Headers for Low-Speed Serial Links." A minimum of 1 compression slot shall be negotiated.[8] The IWF shall support TCP/IP header compression compatible with that required for mobile stations. Negotiation of the parameters of header compression shall be carried out using IPCP, as specified in 2.5.2.

The SNDCF sublayer shall accept network layer datagrams from the network layer, perform header compression as required, and pass the datagram to the PPP layer, indicating the appropriate PPP protocol identifier. The SNDCF sublayer shall receive network layer datagrams with compressed or uncompressed headers from the PPP layer, decompress the datagram header as necessary, and pass the datagram to the network layer.

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[7] The IP address should have a valid format as if it were assigned by IANA. However, for async data and fax services, IP addresses need not be requested from IANA if the Internet is not used as part of the intersystem network.

[8] Implementation note: the code provided in RFC 1144 will not work with less than 3 compression slots. Also, if the mobile station is to support additional data services, it should allocate additional slots. A minimum of 4 compression slots is recommended for such mobile stations.

2.5.2 PPP Layer

The data link layer uses PPP, as described in RFC 1661, "The Point-to-Point Protocol (PPP)," and RFC 1662, "PPP in HDLC Framing," for datagram encapsulation and framing, respectively. The PPP Link Control Protocol (LCP) is used for initial link establishment, and to negotiate optional link capabilities.

The data link layer uses "The PPP Internet Protocol Control Protocol (IPCP)," as described in RFC 1332, to negotiate IP addresses and TCP/IP header compression.

The PPP layer shall accept header compressed network layer datagrams from the SNDCF, and shall encapsulate them in the PPP Information field. The packet shall be framed using the octet-synchronous framing protocol defined in RFC 1662, except that there shall be no inter-frame fill (see 4.1.1 of RFC 1662): No flag octets shall be sent between a flag octet that ends one PPP frame and the flag octet that begins the subsequent PPP frame. The framed PPP packets shall be passed to the RLP layer for transmission.

The data link layer shall accept received octets from the RLP layer, and re-assemble the original PPP packets. The PPP process shall discard any PPP packet for which the received Frame Check Sequence (FCS), specified in 3.1 of RFC 1662, is not equal to the computed value.

2.5.3 IPCP

The IPCP sublayer shall support negotiation of the IP-address (type = 3) and IP-Compression-Protocol (type = 2) parameters.

IPCP shall negotiate a temporary IP address for the mobile station whenever a transport layer connection is actively opened. Mobile stations shall maintain the temporary IP address only while a transport layer connection is open or is being opened, and shall discard the temporary IP address when the transport layer connection is closed.

2.5.4 Link Control Protocol

If the protocol identifier is 0xc021, the PPP layer shall process the packet according to the PPP Link Control Protocol (LCP). If the protocol identifier is 0x8021, the IPCP sublayer shall process the packet. For other supported protocol identifiers,[9] the PPP layer shall remove the PPP encapsulation and shall pass the datagram and protocol identifier to the SNDCF. For unsupported protocol identifiers, the LCP Protocol-Reject shall be passed to the RLP layer for transmission.

The mobile station shall support the PPP LCP Configure-Request, Configure-Ack, Configure-Nak, Configure-Reject, Terminate-Request, Terminate-Ack, Code-Reject, and Protocol-Reject. Other LCP packet types may also be supported.

The PPP LCP shall negotiate the following configuration options:

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[9] The protocol identifiers required by this standard are 0x0021, 0x002d, 0x002f, 0xc021, and 0x8021.

- Async control character map. The mobile station shall not require any mapping of control characters. The IWF may negotiate mapping of control characters.
- Protocol field compression (applied when the protocol number is less than 0xff).
- Address and control field compression (applied when the protocol number is not 0xc021).

The mobile station may support other configuration options (such as maximum receive unit, authentication protocol, link quality protocol, or magic number). When an option is received which is not supported, the Configure-Reject shall be sent as an indication to the peer.

2.5.5 Requirements for Async Data and Fax

2.5.5.1 Traffic Channel Usage

The RLP layer supporting the async data or fax service option shall be carried as primary traffic, or secondary traffic.

When a traffic channel is activated and the async data or fax service option becomes active, the RLP layer shall perform the initialization/reset procedure specified in [7].

No text.

3 REQUIREMENTS FOR THE RADIO INTERFACE

The mobile station and the BS/MSC shall support the physical layer, multiplex sublayer, radio link management, and call control as defined in [2], [3], [4], and [5].

The mobile station and the BS/MSC shall not use quarter-rate frames to carry Service Option 4, 5, 4100, 4101, 12, or 13 data when Multiplex Option 1 is negotiated.

3.1 Service Option Number

The mobile station and the BS/MSC shall use Service Option 4 or Service Option 4100 for asynchronous data service and Service Option 5 or Service Option 4101 for Group-3 fax service when Multiplex Option 1 is the desired default multiplex option, or when service option negotiation is used.

When Multiplex Option 2 is desired as the default multiplex option and service negotiation is used, the mobile station and the BS/MSC shall use Service Option 12 for asynchronous data services and 13 for Group-3 fax services.

Mobile stations supporting Service Option 12 shall also support Service Option 4 and Service Option 4100. Similarly, mobile stations supporting Service Option 13 shall support Service Option 5 and Service Option 4101.

3.2 Multiplex Option Interface

Service Option 4, Service Option 5, Service Option 4100 and Service Option 4101 shall support an interface with Multiplex Option 1 and may support an interface with Multiplex Option 2. RLP frames for Service Option 4, Service Option 5, Service Option 4100 and Service Option 4101 shall only be transported as primary traffic when service option negotiation is used. When service negotiation is used, Service Option 4, Service Option 5, Service Option 4100 and Service Option 4101 shall be transported as primary or secondary traffic.

Service Option 12 and Service Option 13 shall support an interface with Multiplex Option 2 and may support an interface with Multiplex Option 1. RLP frames for Service Options 12 and 13 shall only be transported as primary traffic or as secondary traffic.

3.3 Procedures Using Service Option Negotiation

The mobile station may perform service option negotiation for Service Option 4, Service Option 5, Service Option 4100 and Service Option 4101 as described in [5]. The BS/MSC may perform service option negotiation for Service Option 4, Service Option 5, Service Option 4100 and Service Option 4101 as described in [5]. The mobile station and the BS/MSC shall not perform service option negotiation for Service Options 12 and 13.

The implicit service configuration associated with Service Options 4, 5, 4100 and 4101 when service option negotiation is used is shown in Table 3.3-1.

Table 3-1. Implicit Service Configuration Attributes for Service Options 4, 5, 4100 or 4101 when Service Option Negotiation is Used

Service Configuration Attribute	Valid Selections
Forward Multiplex Option	Multiplex Option 1
Reverse Multiplex Option	Multiplex Option 1
Forward Transmission Rates	Rate Set 1 with full rate, half rate and eighth rate frames enabled.
Reverse Transmission Rates	Rate Set 1 with full rate, half rate and eighth rate frames enabled.
Forward Traffic Type	Primary Traffic
Reverse Traffic Type	Primary Traffic

3.3.1 Initialization and Connection of the Service Option

3.3.1.1 Mobile Station Requirements

If the mobile station sends a *Service Option Response Order* accepting Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101 in response to receiving a *Service Option Request Order*, (see [5]), the mobile station shall initialize and connect Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101 according to the following:

- If the mobile station is in the *Conversation Substate*, the mobile station shall complete the initialization and connection of the transmitting and receiving sides within 200 ms from the later of:
  - The implicit or explicit action time associated with the *Service Option Request Order* (see [5]), or
  - The time that the mobile station sends the *Service Option Response Order* accepting Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101.
- If the mobile station is not in the *Conversation Substate*, the mobile station shall complete the initialization and connection of the transmitting and receiving sides within 200 ms from the later of:
  - The implicit or explicit action time associated with the *Service Option Request Order*,
  - The time that the mobile station sends the *Service Option Response Order* accepting Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101, or
  - The time that the mobile station enters the *Conversation Substate*.

If the mobile station receives a *Service Option Response Order* accepting its request for Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101 (see [5]), the mobile station shall initialize and connect Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101 according to the following:

- If the mobile station is in the *Conversation Substate*, the mobile station shall complete the initialization and connection of the transmitting and receiving sides within 200 ms of the implicit or explicit action time associated with the *Service Option Response Order* (see [5]).
- If the mobile station is not in the *Conversation Substate*, the mobile station shall complete the initialization and connection of the transmitting and receiving sides within 200 ms from the later of:
  - The implicit or explicit action time associated with the *Service Option Response Order*, or
  - The time that the mobile station enters the *Conversation Substate*.

When the transmitting side of Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101 is connected, the service option shall generate and transfer RLP frame data to the multiplex sublayer. When the receiving side is connected, the service option shall transfer and process RLP frame data from the multiplex sublayer. See [5], for the actions to be taken when the transmitting side of a service option is not connected.

3.3.1.2 BS/MSC Requirements

The BS/MSC should wait until the action time associated with the most recently transmitted *Service Option Response Order* or *Service Option Request Order* before initializing and connecting Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101.

When the transmitting side of Service Option 4, Service Option 5, Service Option 4100 or Service Option 4101 is connected, the service option shall generate and transfer RLP frame data to the multiplex sublayer. When the receiving side is connected, the service option shall transfer and process RLP frame data from the multiplex sublayer. See [5], for the actions to be taken when the transmitting side of a service option is not connected.

3.4 Procedures Using Service Negotiation

3.4.1 Mobile Station Requirements

The mobile station shall perform service negotiation as described in [5], and the negotiated service configuration shall include only valid attributes for the negotiated service option as specified in Tables 3.4.1-1 and 3.4.1-2.

When service negotiation is used, Service Option 4 and Service Option 4100 may be carried on either primary or secondary traffic channels. The default Forward Traffic Type for Service Option 4 and Service Option 4100 shall be primary traffic. Service Option 4101 shall be carried as primary traffic only. If Service Option 5 and Service Option 4101 is to be established in accordance with option b of 4.1.1 (*i.e.* the modem configuration includes the “speaker on until connect” feature), Service Option 5 and Service Option 4101 shall be

carried as secondary traffic only for the portion of the call during which there is a voice service option simultaneously connected as primary traffic.

When service negotiation is used, Service Option 12 may be carried on either primary or secondary traffic channels. The default Forward Traffic Type for Service Option 12 shall be primary traffic. Service Option 13 shall be carried as primary traffic only. If Service Option 13 is to be established in accordance with option b of 4.1.1 (*i.e.* the modem configuration includes the "speaker on until connect" feature), Service Option 13 shall be carried as secondary traffic only for the portion of the call during which there is a voice service option simultaneously connected as primary traffic.

Table 3-2. Valid Service Configuration Attributes for Service Options 4, 5, 4100 and 4101

Service Configuration Attribute	Valid Selections
Forward Multiplex Option	Multiplex Option **1** or 2
Reverse Multiplex Option	Multiplex Option **1** or 2
Forward Transmission Rates	**Rate Set 1 with full rate, half rate and eighth rate frames enabled.** Rate Set 2 with all rates enabled.
Reverse Transmission Rates	**Rate Set 1 with full rate, half rate and eighth rate frames enabled.** Rate Set 2 with all rates enabled.
Forward Traffic Type	**Primary Traffic** or Secondary Traffic.
Reverse Traffic Type	Shall be the same as the Forward Traffic Type.

Table 3-3. Valid Service Configuration Attributes for Service Options 12 and 13

Service Configuration Attribute	Valid Selections
Forward Multiplex Option	Multiplex Option 1 or **2**
Reverse Multiplex Option	Multiplex Option 1 or **2**
Forward Transmission Rates	Rate Set 1 with full rate, half rate and eighth rate frames enabled. **Rate Set 2 with all rates enabled.**

Reverse Transmission Rates	Rate Set 1 with full rate, half rate and eighth rate rates frames enabled. **Rate Set 2 with all rates enabled.**
Forward Traffic Type	**Primary Traffic** or Secondary Traffic
Reverse Traffic Type	Shall be the same as the Forward Traffic Type.

If the mobile station accepts a service configuration, as specified in a *Service Connect Message*, that includes a service option connection using service options 4, 5, 4100, 4101, 12, or 13, the mobile station shall perform the following:

- If the mobile station is in the *Conversation Substate*, and the service option connection is not part of the previous service configuration the mobile station shall initialize and connect the service option at the action time associated with the *Service Connect Message*. The mobile station shall complete the initialization within 200 ms of starting the connection.
- If the mobile station is not in the *Conversation Substate*, the mobile station shall initialize and connect the service option no later than the action time associated with the *Service Connect Message*. The mobile station shall complete the connection of the service option within 200 ms of starting the connection.

Commencing at the time when the service option is connected and continuing for as long as the service configuration includes the service option connection, the service option shall generate and transfer RLP frame data to the multiplex sublayer. The service option shall also transfer and process RLP frame data received from the multiplex sublayer.

When the transmitting side of the service option is connected, the service option shall generate and transfer RLP frame data to the multiplex sublayer. When the receiving side is connected, the service option shall transfer and process RLP frame data from the multiplex sublayer. See [5] for the actions to be taken when the transmitting side of a service option is not connected.

3.4.2 BS/MSC Requirements

If the BS/MSC establishes a service configuration, as specified in a *Service Connect Message*, that includes a service option connection using Service Options 4, 5, 4100, 4101, 12, or 13, the BS/MSC shall connect the service option no later than the action time associated with the *Service Connect Message.*

Commencing at the time when the service option is connected and continuing for as long as the service configuration includes the service option connection, the service option shall process received RLP data frames and generate and supply RLP data frames for transmission in accordance with this standard.

When the transmitting side of the service option is connected, the service option shall generate and transfer RLP frame data to the multiplex sublayer. When the receiving side is connected, the service option shall transfer and process RLP frame data from the multiplex

sublayer. See [5] for the actions to be taken when the transmitting side of a service option is not connected.

4 REQUIREMENTS FOR U_M INTERFACE CALL PROCESSING

4.1 Connection Establishment

4.1.1 Mobile Origination

The mobile station shall initiate an async data or fax connection by the following procedure:

When the mobile station application interface requests initiation of an async data or fax connection, it shall issue an active OPEN call to the transport layer. The OPEN call shall specify the modem server port number (380) as destination port, with the source and destination IP addresses unspecified. The IP addresses shall be provided to the Network Layer after completion of IPCP configuration. Transport layer data shall not be sent on the U_m interface prior to completion of IPCP configuration.

Call origination may be carried out in the following ways. BS/MSCs shall support (a) below, and may support (b) and/or (c). Options (a) and (c) are applicable to mobile stations and BS/MSCs that support either service option negotiation or service negotiation procedures. Option (b) below is only applicable to mobile stations and BS/MSCs that support service negotiation procedures.

a. If the origination is initiated as a data or fax call (ATD command or appropriate AT+CXT setting followed by unrecognized modem commands) and the modem configuration includes the “speaker off” setting (ATM0 or default) the mobile station shall perform the *Mobile Station Origination Operation* as defined in [5] requesting the appropriate data service option number.

If the origination is initiated as a result of an ATD command, the mobile station shall place the dial string in the *Origination Message*. The mobile station shall include as many characters of the dial string as possible without exceeding the message capsule size. The mobile station shall include the entire dial string in the ATD command sent to the IWF.

If the origination is initiated as a result of an unrecognized command, the mobile station shall place the unrecognized command, including the initial “AT”, in the *Origination Message*. The mobile station shall include as many characters of the command as possible without exceeding the message capsule size.

The IWF should assign an IP address for the mobile station and issue a passive OPEN call with the foreign network address and port number unspecified to the transport layer. The OPEN call shall specify the modem server port number (380) as the local port, with the IWF’s IP address as the local address.

Subsequent mobile station and BS/MSC call state transitions shall follow the requirements of [5]. When the mobile station and the BS/MSC enter the *Conversation Substate* they may perform service negotiation (see [5]) to establish a service configuration including the requested data service option. Following connection of the requested service option, the mobile station, BS/MSC, and IWF shall perform the actions specified in 4.1.4.

If the origination is initiated as a result of an ATD command, and the mobile station did not send the complete dial string in the *Origination Message*, the mobile station shall

send the remaining characters of the dial string to the BS/MSC in the *Origination Continuation Message*. The mobile station shall send the *Origination Continuation Message* as a message requiring acknowledgment (see [5]) within T_{54m} seconds (defined in [5]) after entering the *Conversation Substate*.

b. If the origination is initiated as a data or fax call (ATD command or appropriate AT+CXT setting followed by unrecognized modem commands) and the modem configuration includes the "speaker on until connect" setting (ATM1) the mobile station shall perform the *Mobile Station Origination Operation* as defined in [5] requesting the appropriate data service option number.

If the origination is initiated as a result of an ATD command, the mobile station shall place the dial string in the *Origination Message*. The mobile station shall include as many characters of the dial string as possible without exceeding the message capsule size. The mobile station shall include the entire dial string in the ATD command sent to the IWF.

If the origination is initiated as a result of an unrecognized command, the mobile station shall place the unrecognized command, including the initial "AT", in the *Origination Message*. The mobile station shall include as many characters of the command as possible without exceeding the message capsule size.

The IWF should assign an IP address for the mobile station and issue a passive OPEN call with the foreign network address and port number unspecified to the transport layer. The OPEN call shall specify the modem server port number (380) as the local port, with the IWF's IP address as the local address.

Subsequent mobile station and BS/MSC call state transitions shall follow the requirements of [5]. When the mobile station and BS/MSC enter the *Conversation Substate* they may perform service negotiation (see [5]) to establish a service configuration including the requested data service option. Following connection of the requested service option, the mobile station, BS/MSC, and IWF shall perform the actions specified in 4.1.4.

If the origination is initiated as a result of an ATD command, and the mobile station did not send the complete dial string in the *Origination Message*, the mobile station shall send the remaining characters of the dial string to the BS/MSC in the *Origination Continuation Message*. The mobile station shall send the *Origination Continuation Message* as a message requiring acknowledgment (see [5]) within T_{54m} seconds (defined in [5]) after entering the *Conversation Substate*.

When the transport layer connection is in the ESTABLISHED state, the mobile station should negotiate a service configuration including a voice service option as primary traffic on the forward link and the requested data service option as secondary traffic.

When this service configuration is established, the BS/MSC should connect the PSTN audio to the mobile station through the Forward Traffic Channel. The mobile station should transmit Reverse Traffic Channel data in accordance with the requirements of the connected service configuration. The BS/MSC should not connect any reverse link voice signals to the PSTN. While the voice service option is active, the BS/MSC should generate DTMF signals on the PSTN in response to signaling messages pertaining to DTMF, received from the mobile station.

When this service configuration is established, the mobile station should send the dialing command (ATD) to the IWF as secondary traffic. Data carried by RLP while the data service option is connected as secondary traffic should be limited to commands from the mobile station application interface layer and responses from the IWF.

When the mobile station detects that the IWF has asserted circuit 109 (CF), the mobile station should initiate service negotiation procedures with the BS/MSC to re-establish the initially requested service configuration. The BS/MSC should disconnect the PSTN audio from the Forward Traffic Channel at this time.

When the async data or fax service option is connected, the RLP layer shall be re-established on the traffic type originally negotiated.

c. If the origination is initiated as a voice call, the mobile station may either transmit an *Origination Message* following the requirements of [5] or may send an AT+CDV command, following the procedures of [8].

If the mobile station receives an ATD or ATA command on the R_m interface while the mobile station is in the *Mobile Station Control on the Traffic Channel State,* the mobile station should transmit a *Service Option Request Order* or a *Service Request Message* to connect the appropriate data or fax service option and should issue an OPEN request to the transport layer, as described above.

The IWF should assign an IP address for the mobile station and issue a passive OPEN call with the foreign network address and port number unspecified to the transport layer. The OPEN call shall specify the modem server port number (380) as the local port, with the IWF's IP address as the local address.

When the data or fax service option is connected, the mobile station, BS/MSC, and IWF shall perform the procedures specified in 4.1.4.

4.1.2 Mobile Termination

When a call is to be terminated to a mobile station directory number, the BS/MSC should determine the mobile station ID of the associated mobile station, and send a *Page Message* or *General Page Message* to that mobile station. The *Page Message* or *General Page Message* should include the appropriate Service Option number.[10] Following connection of the requested service option, the mobile station, BS/MSC, and IWF shall perform the actions specified in 4.1.4. For async data and fax calls, the IWF should assign an IP address for the mobile station and issue an active OPEN call to the transport layer. The OPEN call shall specify the modem client port number (379) as destination, with the IWF's IP address as the source address and the mobile station's assigned IP address as the destination address.

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[10] Methods for determining the service option number for mobile-terminated async data or fax calls are outside the scope of this standard. Approaches include a distinct directory number for each service option, two-stage dialing, and service option switching.

The mobile station shall always respond to a *Page Message* or *General Page Message* specifying data or fax service options.

Mobile stations may also be configurable to accept only async data or fax service options. If so configured, a mobile station may respond to a *Page Message* or *General Page Message* by including a request for these service options.

When the mobile station user configures the async data or fax service for auto-answer mode (by setting the S0 register to a nonzero value), the mobile station shall perform auto-answer, defined as follows:

After the mobile station enters the *Waiting for Mobile Station Answer Substate* the mobile station shall send a *Connect Order* after the time specified in register S0, and shall immediately enter the *Conversation Substate*.

If the mobile station enters the *Conversation Substate* in this manner, the mobile station shall perform the following actions:

- If a service option other than async data or fax is connected the mobile station shall perform one of the following:
  - If service option negotiation is used the mobile station shall initiate service option negotiation to change to the async data or fax service option, as appropriate for the current stored modem configuration. Service option negotiation shall be completed as specified in [5].
  - If service negotiation is used, the mobile station shall negotiate a service configuration to connect the async data or fax service option as appropriate for the current stored modem configuration. Service negotiation shall be completed as specified in [5].
- The mobile station application interface shall issue a passive OPEN call with the foreign network address and port number unspecified to the transport layer. The OPEN call shall specify the modem client port number (379) without a local network (IP) address.

When the async data or fax service option becomes connected while in the *Conversation Substate,* the mobile station application interface shall send the answer command ("ATA"), preceded by configuration commands as required in [8], prior to sending any other data from the R_m interface.

4.1.3 Service Option Change to Group-3 Facsimile Service

If the mobile station and the BS/MSC are in the *Conversation Substate* with a connected service option other than Group-3 fax, service negotiation procedures consistent with [5] may be performed to connect a fax service option. Following connection of the negotiated service option, the mobile station, the BS/MSC and the IWF shall perform the actions specified in 4.1.4. Service negotiation may be initiated in one of the following scenarios:

- If the PSTN fax machine is the fax calling station, either the mobile station or the BS/MSC may detect T.30 CNG tone and initiate service negotiation procedures.

- If the mobile station is the fax calling station, the MT2 or MT0 shall initiate service negotiation procedures in response to the ATD command with no dialed number.

The BS/MSC should indicate the call type of the initial call: mobile terminated or mobile originated. The IWF should assign an IP address for the mobile station and perform one of the following actions:

- If the initial call was mobile terminated, the IWF shall issue an active OPEN call with the foreign network address and port number unspecified to the transport layer. The OPEN call shall specify the modem client port number (379) as the destination, with the IWF's IP address as the source address and the mobile station's assigned IP address as the destination address.
- If the initial call was mobile originated, the IWF shall issue a passive OPEN call with the foreign network address and port number unspecified to the transport layer. The OPEN call shall specified the client server port (380) as the local port, with the IWF's IP address as the source address.
- If the PSTN fax machine is the fax calling station, upon receiving an ATA command, the IWF shall send a CED tone to the PSTN fax machine.
- If the mobile station is the fax calling station, upon receiving an ATD command without a dialed number, the IWF shall send a CNG tone to the PSTN fax machine.

When the fax service option becomes connected while in the *Conversation Substate*, the mobile station shall perform the following actions:

- If the PSTN fax machine is the fax calling station, the MT2 shall generate and send a RING result code to the TE2 after sending the stored configuration string to the IWF. The MT2 should repeat sending the RING result code as many times as specified in Register S0 until an ATA command is received.
- If the initial call was mobile terminated, the mobile station application interface shall issue a passive OPEN call with the foreign network address and port number unspecified to the transport layer. The OPEN call shall specify the modem client port number (379) without a local network (IP) address.
- If the initial call was mobile originated, the mobile station application interface shall issue an active OPEN call to the transport layer. The OPEN call shall specify the modem server port number (380) as destination port, with the source and destination IP addresses unspecified.

4.1.4 Group-3 Facsimile Service Option Change to Voice Service

Support of this feature is optional for both mobile station and base station.

Is the mobile station and BS/MSC are in the *Conversation Substate* with a connected service option to Group-3 fax, a fax interrupt procedure negotiation consistent with T.30 and TIA/EIA-592 followed by service negotiation procedures consistent with [5] may be performed to connect a voice service option.

A fax interrupt procedure begins with an interrupt procedure request, which may be initiated by the mobile station or the PSTN fax machine. A TE2 initiates such a request by

sending appropriate commands[11] defined in [8] to the IWF. Upon receiving that, the IWF transmits appropriate T.30 commands to start the procedure interrupt negotiation with the PSTN fax machine.

During the interrupt procedure negotiation, the IWF sends the mobile station a +FVO response command, as specified in TIA/EIA-592, for soliciting possible user input. If user accepts (or the mobile station is configured to accept) the interrupt procedure, MT2 sends IWF a voice-request command[12] , as defined in [8], requesting the IWF to complete the interrupt procedure negotiation with the PSTN fax machine.

4.1.5 Conversation Substate

When either the mobile station or the BS/MSC enters the *Conversation Substate* with an async data or fax service option connected, it shall begin RLP initialization/reset as described in [7]. The BS/MSC should also open an L-Interface virtual circuit to the IWF prior to the completion of RLP initialization. When the L-Interface virtual circuit has been opened, the IWF relay layer should signal this event to the PPP layer. The PPP layer and IPCP sublayer in the IWF shall then carry out self-configuration, as described in 2.5.3 and 2.5.4.

The IWF shall send an IPCP Configure-Request with an IP-Compression-Protocol parameter set consistent with 2.5.1 and with the IP-address parameter set to the IP address associated with the assigned IWF. The mobile station shall store the IWF's IP address and shall place the IWF's IP address in the destination address field of all IP datagrams sent while the transport layer remains connected.

If the mobile station's IPCP Configure-Request contains an IP address of all zeros, the IWF shall select an IP address to be used by the mobile station and shall send a Configure-Nak with the IP-address parameter set to the IP address selected. The IWF shall select an IP address for each mobile station using async data or group 3 fax service options conforming with the requirements of 2.4.2. The mobile station's IPCP sublayer shall store the assigned address and pass it to the network layer for use as a source address in all IP datagrams sent to the IWF while the transport layer connection remains open. The remaining exchange of IPCP configuration related messages shall be in accordance with RFC 1661.

When the transport layer enters the ESTABLISHED state, the transport layer may begin sending and receiving characters to/from the peer application interface. The mobile station shall transmit its stored configuration and the AT command that caused the establishment of the transport layer connection in accordance with [8]. The IWF should provide a command state inactivity timer[13] that is started when the transport layer connection enters the ESTABLISHED state and is disabled when an ATA or ATD command is received.

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[11] TE2 uses the data stream transparent command <DLE><pri> if it is the fax sending machine, or the +FPS parameter if it is the fax receiving machine.

[12] MT2 may also send a +FHS response to TE2 to terminate the fax session gracefully.

[13] This timer does not apply to the online command state.

The command state inactivity timer should be restarted when any data are sent to or received from the mobile station on the L interface. If the command state inactivity timer expires, the transport layer connection should be closed, using the procedures of 4.2. The timer duration is set by the AT+CQD command (see [8]).

4.1.6 Traffic Channel Handoff

Soft handoff (see [5]) or a CDMA-to-CDMA hard handoff (see [5]) entailing only a change in the frame offset field shall not affect the state of any of the protocols for async data or fax.

Following a CDMA-to-CDMA hard handoff (see [5]) involving transitions between disjoint sets of BS/MSCs or a frequency change, the RLP layer shall be reset and immediately re-established. This is necessary to ensure proper re-establishment of RLP after an intersystem handoff, which is not distinguishable from other hard handoffs. Data lost during the reset of RLP will be retransmitted by the transport layer.

CDMA-to-analog handoffs are not supported for Service Options 4, 5, 4100, 4101, 12, and 13. The mobile station and the IWF shall close the transport layer connection if the mobile station moves outside of CDMA coverage (see 3.9.2).

4.2 Connection Release

The async data or fax service is considered connected when the transport layer is in the ESTABLISHED state.

Each of the following conditions shall cause the transport layer connection to be closed by means of the CLOSE call to the transport layer:

- The application interface directs the transport layer to close the connection.
- The command state inactivity timer expires, as specified in 4.1.3.
- The IWF detects that the PSTN connection has been lost or that the remote modem or fax device has released the connection.
- The IWF is directed to release the call (ATH command).
- The mobile station moves away from CDMA coverage.
- The end-to-end connect timer (register S7) expires.
- An appropriate valid response is not timely received from the PSDN fax machine, as specified in T.30, during the interrupt procedure negotiation.

If the IWF detects a transport layer failure, as specified in 2.3, the IWF shall close the transport layer by means of an ABORT call. If the IWF closes the transport layer in this manner, the IWF should release the L-Interface virtual circuit.

If the IWF closes the L-Interface virtual circuit, the BS/MSC should release the traffic channel to the Mobile Station, and should release the PSTN call.

The BS/MSC should close the L-Interface virtual circuit, and release the PSTN call when any of the following occur:

- The BS/MSC receives a *Release Order* with a power-down indication.
- The BS/MSC cannot support the requested service option.

- The mobile station releases the traffic channel.[14]

- A *Lock Order* is sent to the mobile station.

The mobile station shall close the transport layer by means of an ABORT call to the transport layer if any of the following occur:

- The mobile station powers down.
- The mobile station receives a *Release Order* indicating that the requested service option is rejected.
- A *Lock Order* is received by the mobile station.

When the transport layer is to be closed via a CLOSE call to the transport layer and a traffic channel is active, the mobile station or BS/MSC shall perform the following:

- If the connection is to be closed because the mobile station is powering down, the mobile station may send a *Release Order* with power-down indication and immediately power down.
- In all other cases, the transport layer initiating the close shall close the connection in accordance with the requirements of RFC 793.

4.3 Authentication

Authentication of mobile station initiated data calls shall be conducted according to the procedure described in [5]. For mobile-originated data calls, the BS/MSC should complete an authentication Unique Challenge immediately after assigning the traffic channel, and before connecting the async data or fax service option.

[14] Support of dormant mode and automatic reconnect are for further study. These features will require maintaining the transport layer connection after a call release or drop.

5 RECOMMENDATIONS FOR THE MODEM TO PSTN INTERFACE

5.1 Recommended Modem Standards

The IWF should support the following modem standards for asynchronous data and fax service: V.21, V.22, V.22*bis*, V.32, V.32*bis*, V.42, V.42*bis*, V.17, V.27*ter*, and V.29. The IWF may support V.34, Bell 103, and Bell-212A.

This standard also provides AT command support for Telephone Devices for the Deaf (TDD). IWF manufacturers supporting digital TDD services should support the following modem standards (see ITU-T V.18 - 1994): V.21, V.21 reversed, V.23, Baudot, Bell 103, DTMF Coding, and European Deaf Telephone (EDT) mode.

5.2 Flow Control

5.2.1 Flow Control for Async Data

The IWF may implement flow control over the A_i interface in one of two ways:

- By use of V.42. This protocol allows for flow control between the IWF and the remote PSTN DCE.
- If software flow control is enabled on the PSTN interface the IWF may send (and shall interpret) XON and XOFF. This allows for flow control between the IWF and the remote terminal.[15]

5.2.2 Flow Control for Group-3 Fax

The PSTN interface can operate at higher rates than are possible on the U_m interface. The rate discrepancy results in buffering requirements at the BS/MSC and IWF and, eventually, for a need to flow control the land side fax machine. Since Group-3 fax is a half-duplex service, there is no mechanism for providing true flow control over the PSTN but indirect methods that accomplish a form of flow control can be used under some circumstances.

[15] This standard does not specify means for a mobile station to enable or disable software flow control at the IWF. IWFs may implement special purpose AT commands for this purpose. A TE2 or an MT0 application may transmit such commands using the AT+CXT and AT+CFG cellular extensions.

No text.