

INDEPENDANT SYNCHRONISATION OF PPP LINKS ON UM AND RM INTERFACES

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BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to the field of wireless data services. More particularly, the present invention relates to a novel and improved method and system for resynchronizing a Point-to-Point Protocol (PPP) link over a U_m interface between a wireless communication device (MT2) and a base station/mobile switching center (BS/MSC) without affecting a R_m interface between the wireless communication device (MT2) and a TE2 device.

15 II. Description of Related Art

Internetworking, i.e., the connection of individual local area networks (LANs), has rapidly become very popular. The infrastructure and associated protocols commonly referred to as the "Internet" have become well known and widely used. A well known protocol for providing access to the Internet is the Point-to-Point Protocol (PPP) which provides a standard method for transporting multi-protocol datagrams over point-to-point, and is further described in Request for Comment (RFC) 1661, Network Working Group, W. Simpson, Editor, July 1994, herein incorporated by reference.

PPP includes three main components:

- 25 1. a method of encapsulating multi-protocol datagrams;
2. a Link Control Protocol (LCP) for establishing, configuring, and testing a data link connection; and
3. a family of Network Control Protocols (NCPs) for establishing and configuring different network-layer protocols.

30 FIG. 1 illustrates a high-level block diagram of a wireless data communication system in which a mobile terminal (TE2 device) 102 communicates with an interworking function (IWF) 108 via a wireless

communication system which includes a wireless communication device (MT2) 104 and Base Station/Mobile Switching Center (BS/MS) 106. In FIG. 1, the IWF 108 serves as the access point to the Internet. IWF 108 is coupled to, and often co-located with BS/MS 106, which may be a conventional wireless base station, as is known in the art. TE2 device 102 is coupled to MT2 device 104 (which may be a cellular phone), which is in wireless communication with BS/MS 106 and IWF 108.

Many protocols exist which allow data communication between the TE2 device 102 and the IWF 108. For example, Telecommunications Industry Association (TIA)/Electronics Industries Association (EIA) Interim Standard IS-707.5, entitled "Data Service Options for Wideband Spread Spectrum Systems: Packet Data Services," published February 1998, and herein incorporated by reference, defines requirements for support of packet data transmission capability on TIA/EIA IS-95 wideband spread spectrum systems, of which BS/MS 106 and IWF 108 may be a part. IS-707.5 also provides the requirements for communication protocols on the links between the TE2 device 102 and the MT2 device 104 (the R_m interface), between the MT2 device 104 and the BS/MS 106 (the U_m interface), and between the BS/MS 106 and the IWF 108 (the L interface).

Referring now to FIG. 2, a diagram of the protocol stacks in each entity of the IS-707.5 Relay Model is shown. FIG. 2 corresponds roughly to Figure 1.4.2.2-1 of IS-707.5. At the far left of the figure is a protocol stack, shown in conventional vertical format, showing the protocol layers running on the TE2 device 102 (e.g., the mobile terminal, laptop or palmtop computer). The TE2 protocol stack is illustrated as being logically connected to the MT2 device 104 protocol stack over the R_m interface. The MT2 device 104, is illustrated as being logically connected to the BS/MS 106 protocol stack over the U_m interface. The BS/MS 106 protocol stack is, in turn, illustrated as being logically connected to the IWF 108 protocol stack over the L interface.

As an example of the operation of the protocols of Fig. 2, the Point to Point Protocol (PPP_R) protocol 206 encodes packets from the upper layer protocols 202, 204 and transmits them across the R_m interface using the EIA-

232 protocol 208 to the EIA-232-compatible port on the MT2 device running the EIA-232 protocol 210. The present invention is not intended to be limited to a system that uses the EIA-232 protocol since, as is well known, other suitable protocols such as USB are also available. The EIA-232 protocol 210 on the MT2 device, receives the packets and passes them to the PPP_R protocol 205. The PPP_R protocol 205 unframes the packets encapsulated in PPP frames and typically, when a data connection is up, passes the packets to PPP_U protocol 215, which frames the packets in PPP frames for transmission to a PPP peer located in the IWF (108). The Radio Link Protocol (RLP) 212 and IS-95 protocol 214, both of which are well known in the art, are used to transmit the packets, which are encapsulated in PPP frames, to the BS/MS 106 over the U_m interface. The RLP protocol 212 is defined in Telecommunications Industry Association (TIA)/Electronics Industries Association (EIA) Interim Standard IS-707.2, entitled "Data Service Options for Wideband Spread Spectrum Systems: Radio Link Protocol", February 1998, herein incorporated by reference, and the IS-95 protocol is defined in IS-95 mentioned above. A complementary RLP protocol 216 and IS-95 protocol 218 in the BS/MS 106 pass the packets to the relay layer protocol 220 for transmission across the L interface to relay layer protocol 228. PPP_U protocol 226 then unframes the received packets and passes them to the network layer protocols 225, which in turn sends them out on the internet to the designation server.

As described in RFC 1661, the LCP Packets comprise a Configure-Request, a Configure-Ack, a Configure-Nak, and a Configure-Reject. The format of these packets is well known and described in RFC 1661.

The Configure-Request packet is used to negotiate configuration options. All configuration options are always negotiated simultaneously.

The Configuration-Ack packet is transmitted if every configuration option in a received Configuration-Request packet is recognizable and all values are acceptable.

The Configure-Nak packet is sent in response to a Configuration-Request packet when the requested configuration options are recognizable, but some of the values are not acceptable. The Options field of the

Configure-Nak packet are filled only with the unacceptable configuration options from the Configure-Request packet. Note that all configuration options are always Nak'd simultaneously.

5 The Configure-Reject packet is sent when a received Configure-Request includes configuration options that are unrecognizable or are not acceptable for negotiation. The options field of the Configure-Reject contains only the unacceptable configuration options from the Configure-Request.

10 The following comprises the well-known configuration options, described in RFC 1661, and defined for the PPP LCP protocol:

1. Maximum-Receive-Unit
2. Authentication-Protocol
3. Quality-Protocol
4. Magic-Number
- 15 5. Protocol-Field-Compression
6. Address-and-Control-Field-Compression

Internet Protocol Control Protocol (IPCP) is a network control protocol responsible for configuring, enabling, and disabling Internet Protocol (IP) modules on both ends of the PPP link. IPCP is described in Request for
20 Comment (RFC) 1332, "The PPP Internet Protocol Control Protocol (IPCP)", Network Working Group, G. McGregor Merit, May 1992, herein incorporated by reference. IPCP configuration options include:

1. IP-Addresses;
2. IP-Compression-Protocol; and
- 25 3. IP-Address

IPCP uses the same option negotiation mechanism as the Link Control Protocol (LCP).

LCP and IPCP Configuration option negotiations occur separately for both the R_m interface and the U_m interface. That is, LCP or IPCP
30 configuration option negotiation over one of the R_m and U_m interfaces is separate from LCP or IPCP configuration option negotiation over the other of the R_m and U_m interfaces. Therefore, the wireless communication device

(MT2) must separately negotiate configuration options over the R_m and U_m interfaces.

Because the wireless communication device (MT2) is mobile, the wireless communication device (MT2) may move to an area that is served by a different BS/MS 106 or a different IWF 108. When this happens, a handoff will occur, handing the MT2 device over to the new BS/MS 106 or a new IWF 108 for service. When a handoff occurs, the LCP and IPCP links must be renegotiated over the U_m interface, as discussed above. Because PPP negotiation for the R_m and U_m interfaces are independent, PPP renegotiation need only occur on the U_m interface.

Under some circumstances, the TE2 device may initiate PPP renegotiation. However, it may be unnecessary to perform PPP renegotiation on the U_m interface when PPP renegotiation occurs on the R_m interface.

SUMMARY OF THE INVENTION

The invention is a method, within a wireless communication system, and an MT2 device which provide for the resynchronization of a PPP link on one of a U_m and R_m interface without affecting the other of the U_m and R_m interface.

Thus, when a handoff is performed, such that the mobile MT2 device is handed off to a new BS/MS, the U_m interface may undergo PPP configuration renegotiation without causing the R_m interface also to undergo PPP configuration renegotiation.

Similarly, the R_m interface may undergo PPP configuration renegotiation without causing the U_m interface also to undergo PPP configuration renegotiation.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other advantages will become more apparent from the detailed description of the preferred embodiments along with the following
5 drawings:

Fig. 1 illustrates a high-level block diagram of a wireless data communication system in which a terminal device connects to a network, such as the Internet, via a wireless communication device;

Fig. 2 is a diagram of the protocol stacks of each entity;

10 Fig. 3 is a state transition diagram which illustrates the state transitions for a first aspect of a preferred embodiment of the invention;

Fig. 4 illustrates the operation of the invention when the U_m interface is renegotiated;

15 Fig. 5 is a state transition diagram which illustrates the state transitions for a second aspect of a preferred embodiment of the invention;

Fig. 6 illustrates the operation of the invention when the R_m interface is renegotiated.

DETAILED DESCRIPTION OF THE PREFERRED 20 EMBODIMENTS

As is known in the art, in order to establish communications over a point-to-point (PPP) link, Link Control Protocol (LCP) packets for establishing, configuring and testing the data link connection must be
25 exchanged over each PPP link, i.e., the R_m and U_m interfaces. Any options not negotiated use a predefined default value, as specified by RFC 1661.

Similarly, IPCP packets for negotiating and configuring IPCP configuration options must be exchanged over the R_m and U_m interfaces. Any options not negotiated use a predefined default value, as specified by
30 RFC 1332.

As described in RFC 1661 and RFC 1332, LCP Packets and IPCP packets comprise a Configure-Request, a Configure-Ack, a Configure-Nak, and a

Configure-Reject. The format of these packets is well known and described in RFC 1661 and RFC 1332, respectively.

Configuration option negotiations may occur separately for both the R_m interface and the U_m interface. As described in RFC 1661 and RFC 1332, the Configure-Request packet contains a list of the options being requested and the Configuration-Ack packet contains a list of the options which the sender is acknowledging.

In order to simplify processing and achieve greater efficiency of processing it is preferable that, as a result of renegotiating the PPP options, the newly negotiated options are the same as the PPP options used prior to renegotiation. However, this is not a requirement. In the event that the newly negotiated PPP options are not the same as the PPP options used prior to renegotiation, the MT2 device would be required to perform additional processing such as described in copending patent application "Selectively Unframing and Framing PPP Packets Depending On Negotiated Options of the U_m and R_m Interfaces", inventors Marcello Liroy and Nish Abrol, assigned to the same assignee (attorney docket D1275).

Because the wireless communication (MT2) device 104 is typically mobile, communications between the MT2 device 104 and a BSC/MS 106 will be handed off to another BSC/MS 106, as necessary depending on the location of the MT2. Handoff techniques are well known in the art. When a handoff occurs, the PPP U_m interface must be renegotiated. That is, the LCP and the IPCP configuration options must be renegotiated over the U_m interface. However, it is not necessary to renegotiate the PPP configuration options over the R_m interface when the U_m interface is renegotiated.

In the preferred embodiment, the MT2 device will attempt to simultaneously negotiate both the R_m and the U_m interfaces by monitoring the received LCP and IPCP configuration request packets on one of the R_m and U_m interfaces, examining the LCP and IPCP configuration packets, and if the requested options are supported by the MT2 device, transmitting the received LCP or IPCP configuration request packet on the other of the R_m and U_m interfaces.

Fig. 3 illustrates a state transition diagram of a first aspect of the invention. Initially, PPP is in the Out of Call state, shown at reference numeral 300. When an LCP packet is received in the MT2 device 104 from either the U_m or R_m interface, PPP enters the R_m and U_m PPP Initialization state, shown at reference numeral 310. In this state, option negotiation occurs on both the R_m and U_m interfaces. When LCP configuration negotiations are complete, then IPCP configuration negotiations are performed. When IPCP negotiations are completed, PPP enters the PPP Up state, shown at reference numeral 320.

While in the PPP Up state, if an LCP or IPCP Configure-Request packet is received on the R_m interface, PPP enters the R_m and U_m PPP Initialization state, and option negotiations take place on both the R_m and U_m interfaces.

While in the PPP Up state it may be necessary to renegotiate PPP over the U_m link. Indication that this is necessary may come in several forms; it could come from the cellular network, for example, in a CDMA network it could be indicated by a new packet zone ID or new SID/NID. It could also come in the form of an LCP configure request or an IPCP configure request. If the indication comes from the cellular network the U_m PPP in the phone can initiate the renegotiation, otherwise no special action needs to be taken.

Upon receiving an indication that renegotiation is necessary the PPP Resync state is entered, shown at reference numeral 330. In the PPP Resync state, the MT2 device 104 will renegotiate the LCP and IPCP options. When IPCP option negotiations are completed, the PPP Up state is again reentered and data transfer may take place.

Fig. 4 provides an example of the operation of the present embodiment. After option negotiation is completed on both the R_m and U_m interfaces, data transfer may take place. At reference numeral 410, the BSC/MS 106 sends an LCP Configure-Request packet, over the U_m interface, to the MT2 device 104. At reference numeral 412, the MT2 device receives the LCP Configure-Request packet while in the PPP Up state, enters the PPP Resync state, and at reference numeral 414, sends a LCP Configure-Ack packet. At reference numeral 416, the MT2 device sends a LCP Configure-Request packet and, at reference numeral 418, the MT2 device receives an

LCP Configure-Ack packet from the BS/MS 106. At this point the LCP configuration options for both ends of the U_m interface have been successfully negotiated. Note that FIG. 4 would have to be modified if the MT2 were to initiate the renegotiation.

5 At reference numeral 420, the BS/MS sends an IPCP Configure-Request packet to the MT2 device. At reference numeral 422, the MT2 device receives the IPCP Configure-Request packet and, at reference numeral 424, responds with an IPCP Configure-Ack packet. At reference numeral 426, the MT2 device sends an IPCP Configure-Request packet. At reference
10 numeral 428, the MT2 device receives an IPCP Configure-Ack packet from the BS/MS. At this point IPCP negotiations are complete and the MT2 device enters the PPP Up state. Thus, the U_m interface has been renegotiated without affecting the R_m interface.

Fig. 5 illustrates a state transition diagram for a second aspect of the
15 invention. LCP and IPCP option negotiations on one of the R_m and the U_m interface do not affect the other of the R_m and U_m interface.

Initially, PPP starts at the Out of Call state, shown at reference numeral 500. When an LCP Configure-Request packet is received on either the R_m or the U_m interface, then PPP enters the R_m and U_m PPP Initialization
20 state, as shown at reference numeral 510. When IPCP option negotiations are completed, PPP enters the PPP Up state, shown at reference numeral 520.

When either an LCP or an IPCP Configure-Request packet are received over the R_m or the U_m interface while in the PPP Up state, then PPP enters the PPP Resync state, shown at reference numeral 530. When IPCP
25 completes option negotiation on the R_m or the U_m interface while in the PPP Resync state, then PPP enters the PPP Up state.

Fig. 6 shows a PPP option negotiation over the R_m interface not affecting the U_m interface. After option negotiation is completed on both the R_m and U_m interfaces, data transfer may take place. At reference numeral 610,
30 the TE2 102 device sends an LCP Configure-Request packet, over the R_m interface, to the MT2 device 104. At reference numeral 612, the MT2 device receives the LCP Configure-Request packet while in the PPP Up state, enters the PPP Resync state, and at reference numeral 614, sends a LCP Configure-

Ack packet. At reference numeral 616, the MT2 device sends a LCP Configure-Request packet and, at reference numeral 618, the MT2 device receives an LCP Configure-Ack packet from the TE2 device 102. At this point the LCP configuration options for both ends of the R_m interface have
5 been successfully negotiated.

At reference numeral 620, the TE2 device sends an IPCP Configure-Request packet to the MT2 device. At reference numeral 622, the MT2 device receives the IPCP Configure-Request packet and, at reference numeral 624, responds with an IPCP Configure-Ack packet. At reference numeral 626,
10 the MT2 device sends an IPCP Configure-Request packet. At reference numeral 628, the MT2 device receives an IPCP Configure-Ack packet from the TE2 device. At this point IPCP negotiations are complete and the MT2 device enters the PPP Up state. Thus, the R_m interface options have been negotiated without affecting the U_m interface.

15 While this invention has been described in connection with what is presently considered to be the preferred embodiment, it is to be understood that the invention is not limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

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We claim:

CLAIMS



1. A method of resynchronizing a first Point-to-Point Protocol link on
2 a U_m interface without resynchronizing a second Point-to-Point Protocol link
on a R_m interface, comprising:
4 checking all packets being received by a MT2 device over said
 U_m interface to determine whether a received packet is a PPP packet for
6 requesting option negotiating;
 negotiating option values of said U_m interface, after said
8 checking determines that said received packet is said PPP packet for
requesting option negotiating.
2. The method according to claim 1, wherein a Point-to-Point Protocol
2 on said MT2 device enters a state for data transfer after said negotiating of
said option values is successfully completed.
3. The method according to claim 2, wherein said checking is
2 performed when said Point-to-Point Protocol is in said state for data transfer.
4. The method according to claim 1, wherein said negotiating
2 comprises negotiating LCP option values.
5. The method according to claim 1, wherein said negotiating
2 comprises negotiating IPCP option values.
6. The method according to claim 1, wherein said negotiating
2 comprises negotiating LCP option values and IPCP option values.
7. A method of resynchronizing a first Point-to-Point Protocol link
2 without resynchronizing a second Point-to-Point Protocol link, comprising:



checking all packets being received by a MT2 device over one of
4 a U_m interface and a R_m interface to determine whether a received packet is a
PPP packet for requesting option negotiating;

6 negotiating option values of said one of said U_m interface and
said R_m interface, after said checking determines that said received packet is
8 said PPP packet for requesting option negotiating.

8. The method according to claim 7, wherein a Point-to-Point Protocol
2 on said MT2 device enters a state for data transfer after said negotiating of
said option values is successfully completed.

9. The method according to claim 8, wherein said checking is
2 performed when said Point-to-Point Protocol is in said state for data transfer.

10. The method according to claim 7, wherein said negotiating
2 comprises negotiating LCP option values.

11. The method according to claim 7, wherein said negotiating
2 comprises negotiating IPCP option values.

12. The method according to claim 7, wherein said negotiating
2 comprises negotiating LCP option values and IPCP option values.

13. A MT2 device capable of resynchronizing a first Point-to-Point
2 Protocol link on a U_m interface without resynchronizing a second Point-to-
Point Protocol link on a R_m interface, comprising:

4 means for checking all packets being received over said U_m
interface to determine whether a received packet is a PPP packet for
6 requesting option negotiation;

means for negotiating option values of said U_m interface, after
8 said checking means determines that said received packet is said PPP packet
for requesting option negotiation.



14. The MT2 device according to claim 13, wherein a Point-to-Point
2 Protocol on said MT2 device enters a state for data transfer after said
negotiating means successfully negotiates said PPP options.

15. The MT2 device according to claim 14, wherein said checking
2 means performs checking of all of said packets when said Point-to-Point
Protocol is in said state for data transfer.

16. The MT2 device according to claim 13, wherein said option values
2 negotiated by said negotiating means comprises LCP option values.

17. The MT2 device according to claim 13, wherein said option values
2 negotiated by said negotiating means comprises IPCP option values.

18. The MT2 device according to claim 13, wherein said option values
2 negotiated by said negotiating means comprises LCP option values and IPCP
option values.

19. A MT2 device capable of resynchronizing a first Point-to-Point
2 Protocol link without resynchronizing a second Point-to-Point Protocol link,
comprising:

4 means for checking all packets being received by a MT2 device
over one of a U_m interface and a R_m interface to determine whether a
6 received packet is a PPP packet for requesting option negotiating;

means for negotiating option values of said one of said U_m
8 interface and said R_m interface, after said checking means determines that
said received packet is said PPP packet for requesting option negotiating.

20. The MT2 device according to claim 19, wherein a Point-to-Point
2 Protocol on said MT2 device enters a state for data transfer after said
negotiating means successfully negotiates PPP options.



21. The MT2 device according to claim 20, wherein said checking
2 means performs checking when said Point-to-Point Protocol is in said state
for data transfer.

22. The MT2 device according to claim 19, wherein said option values
2 negotiated by said negotiating means comprises LCP option values.

23. The MT2 device according to claim 19, wherein said option values
2 negotiated by said negotiating means comprises IPCP option values.

24. The MT2 device according to claim 19, said option values
2 negotiated by said negotiating means comprises LCP option values and IPCP
option values.