

[0001] **METHOD AND APPARATUS FOR
SUPPORTING CIRCUIT SWITCHED INTERWORKING**

[0002] **FIELD OF INVENTION**

[0003] The present invention relates to wireless communication and more particularly to interworking between Internet Protocol (IP) multimedia core network subsystem (IMS) voice/video session and a combination of a circuit switched (CS) call and an IMS session.

[0004] **BACKGROUND**

[0005] Third Generation Partnership Project (3GPP) is in the process of specifying how to combine a circuit switched (CS) call and an IP multimedia core network subsystem (IMS) session and thus the interworking between such services and sessions. There is a need to provide an interworking between 3GPP IMS voice/video session and a combination of a CS call and an IMS session.

[0006] **SUMMARY**

[0007] The invention is related to facilitating a dual mode terminal (WTRU) that is capable of supporting both a Circuit Switched (CS) voice call (e.g., Global System For Mobile Communication (GSM)) and an IMS multimedia session simultaneously without any interruption to either sessions/services. The present invention accommodates the growing demands for the reliable GSM-based CS voice calls with the addition of multimedia services. Pursuant to the present invention, such services are coordinated by providing an apparatus which performs a Circuit Switched Interworking function (CSIWF) in the IMS domain and interfaces with the CS and Packet Switched (PS) domains to enable a combined CS and IMS session while providing both services independently at one wireless unit while both services are combined at the other wireless unit.

[0008] BRIEF DESCRIPTION OF THE DRAWING(S)

[0009] A more detailed understanding of the invention may be had from the following description of a preferred embodiment, given by way of example and to be understood in conjunction with the accompanying drawings wherein:

[0010] Figure 1 shows a signal flow diagram for a wireless call session with combined CS and IMS sessions; and

[0011] Figure 2 shows a signaling sequence diagram between two wireless users for establishing a combined CS and IMS session.

[0012] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0013] Although the features and elements of the present invention are described in the preferred embodiments in particular combinations, each feature or element can be used alone (without the other features and elements of the preferred embodiments) or in various combinations with or without other features and elements of the present invention.

[0014] When referred to hereafter, the terminology "wireless transmit/receive unit (WTRU)" includes but is not limited to a user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a computer, or any other type of device capable of operating in a wireless environment. When referred to hereafter, a base station (BS) includes but is not limited to a Node-B, site controller, access point (AP) or any other type of interfacing device in a wireless environment.

[0015] The present invention handles terminating real-time sessions and calls taking into account different domains (CS, IMS) and different WTRU capabilities (CSI, IMS VoIP, etc.).

[0016] Briefly, a multimedia call is initiated from an IMS- only capable WTRU 12 wherein, the invitation may include Voice component (V) and a media component (M) with their respective attributes (see Figures 1 and 2). The receiving WTRU 10 has a unique configuration which prefers voice calls over GSM (CS domain). Then, once the IMS side of 10b the receiving WTRU 10 accepts the multimedia call with its components, a CS voice bearer is established between the

calling subscriber (an IMS-capable WTRU 12) and the called subscriber (a CS and IMS-capable WTRU 10). The called WTRU 10 acknowledges the voice (V) and multimedia (M) reply (OK) from the calling WTRU 12 through the IMS domain, the Media Gateway (MGW) 26 "rings" the called WTRU 10 and the CS voice call is established when the called WTRU 10 answers. The MGW/MGWF 26 translates the voice call into Voice over IP (VoIP) format. The IMS CSI IWF 20 conveys the media content to the IMS capable portion of the CSI WTRU and supports combined traffic with the IMS domain.

[0017] Figure 1 shows the new Interworking apparatus introduced in an IMS domain in order to control the establishment of a CS voice call combined with an IMS multimedia session between two terminals wherein, one is IMS-only capable and the other is a dual mode (IMS and CS capable) simplified signal flow diagram for a wireless call session between two network transceivers, i.e., a Circuit Switched Interworking (CSI), i.e., a CS and IMS-capable, WTRU 10 and an IMS-capable WTRU 12. WTRU 10 has devices 10a and 10b for respectively supporting CS and IMS, whereas WTRU 12 supports IMS. The domain device 20 combines CS domain content with IMS domain content between the WTRU 10, 12 entities as follows. It should be noted that only two (2) WTRUs are shown in the example of Figure 1 for simplicity, it being understood that other WTRUs may participate in the combined session.

[0018] As shown in Figure 1, and assuming the session has been set up, the IMS session signal S_{IMS} at the CSI WTRU is sent from the IMS Client entity WTRU 10b, and is then processed by the Radio Access Network (RAN) 14, the PS domain entity 18 and the CSI Interworking Function (CSI IWF) entity 20, where it is combined with the CS signal S_{CS} . G_m comprises the interface between the CSI IWF 20, serving as a Proxy-Call Session Control Function (P-CSCF) and IMS portion 10b of WTRU 10. The IWF 20 respectively employs a Serving and a Gateway GPRS Support Node a (GGSN) and a (SGSN) to perform its functions as set forth below.

[0019] The CS signal S_{CS} at the CSI WTRU 10, from CS entity 10a, is communicated to RAN 14 and to CS domain entity 16 over a Uu/Um radio interface. Uu is the interface between the UTRAN (UMTS Terrestrial Radio Access Network)

and a WTRU utilizing CDMA, and CSI IWF entity 20, which combines the S_{CS} session signal with the IMS session signal S_{IMS} in IMS domain. Um is an air interface reference point for the 3GPP2 air interface. It is a wideband spread spectrum interface that utilizes CDMA (Code Division Multiple Access) technology and satisfies the requirements of a 3G (Third Generation) system and also the evolution of the current TIA (Telecommunications Industry Association) / EIA (Electronics Industry Association) 95-B family of standards.

[0020] The combined CS/IMS content signal S_{V&M} is transmitted in both directions between the two network transceivers, i.e., WTRUs 10 and 12 and is made possible by CSI WF 20.

[0021] Making reference to Figure 2, wherein like elements in Figures 1 and 2 are designated by like numerals, there is shown a signalling sequence diagram between the CSI WTRU 10 and the IMS WTRU 12.

[0022] The combined session is initiated at step S₁ by IMS capable WTRU 12, sending an Invite to IMS Domain A 24a for a combined V and M session. The IMS domain is Session Initiation Protocol (SIP)–based and the Invite is an SIP message. The (V and M) Invite is sent to IMS domain B function device 24b at S₂. Device 24b queries Home Location Register/Home Subscriber Server (HLR/HSS) 22 for location and profile, at S₃. It is assumed that the WTRU 10, at S₀, has previously powered up and registered as a CSI capable WTRU and has been assigned an IMS CSI IWF.

[0023] HLR/HSS 22, at S₄, provides the requested location and profile (CSI capable) to device 24b, which sends the V&M Invite to IMS CSI IWF 20 at S₅, which forwards the Invite to IMS capable portion 10b, at S₆.

[0024] WTRU 10 accepts the Invite at S₇ and sends a 200 OK (V&M) to IWF 20, at S₈. IWF 20 sends the OK to IMS domain B at S₉, which forwards the OK to IMS domain A 24, at S₁₀ and initiates establishment of CS and PS radio bearers B_{CS} and B_{PS} at S_{10a}, employing procedural steps S_{10b}, S_{10c} and S_{10d} respectively to IWF 20, MGW/MGW 26 and CSI portion 10a of WTRU 10. IMS domain A 24 sends the OK to WTRU 12 at S₁₁. The CS voice bearer B_{CS} is established between MGW/MGCF 26 CS portion 10a. The PS voice bearer B_{PS} is established between IMS portion 10b and IMS Domain B 24b.

[0025] WTRU 12, at S₁₂, acknowledges the OK and sends an ACK (V&M) to IMS 24A, which sends it to IMS 24B, at S₁₃. IMS 24B forwards the ACK (V&M) to IWF 20, at S₁₄, which forwards only the ACK (M) to IMS portion 10b of WTRU 10 and forwards only ACK (V) IM to MGW/MGCF 26, at S₁₆.

[0026] MGW/MGCF 26 sends a Ringing condition to CS portion 10a of WTRU 10, at S₁₇ to initiate the voice portion of the combined session. CS 10a of WTRU 10 answers the Ringing at S₁₈. WTRU 10 also answers the ACK (M) message at S₁₉.

[0027] The CS voice call session S₂₀ extends between WTRU 10 and MGW/MGCF 26. MGW/MGCF 26 translates the CS voice into Voice over IP (VoIP) format at S₂₁ to provide a VoIP session between MGW/MGCF 26 and IWF 20, at S₂₂.

[0028] The media content, S₂₃, is set up between IWF 20 and IMS portion 10b of WTRU 10. IWF 20, at S₂₄, combines the translated CS voice (i.e., VoIP) and media received from WTRU 10 and sends it to WTRU 12 through IMS domain 24A, which conveys the combined session to and receives it from WTRU 12, at S₂₅, the combined session, represented by S_c, continuing until WTRU terminates the session, sending a BYE (V&M) to IMS A 24A at S₂₆, which forwards the BYE to IWF 20, at S₂₇. IWF 20 sends the BYE to IMS portion 10a of WTRU 10 at S₂₈ and MGW/MGCF 26 at S₂₉, which releases the combined session, at S₃₀.

[0029] Although the features and elements of the present invention are described in the preferred embodiments in particular combinations, each feature or element can be used alone without the other features and elements of the preferred embodiments or in various combinations with or without other features and elements of the present invention. The methods or flow charts provided in the present invention may be implemented in a computer program, software, or firmware tangibly embodied in a computer-readable storage medium for execution by a general purpose computer or a processor. Examples of computer-readable storage mediums include a read only memory (ROM), a random access memory (RAM), a register, cache memory, semiconductor memory devices, magnetic media such as internal hard disks and removable disks, magneto-optical media, and optical media such as CD-ROM disks, and digital versatile disks (DVDs).

[0030] Suitable processors include, by way of example, a general purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs) circuits, any other type of integrated circuit (IC), and/or a state machine.

[0031] A processor in association with software may be used to implement a radio frequency transceiver for use in a wireless transmit receive unit (WTRU), user equipment (UE), terminal, base station, radio network controller (RNC), or any host computer. The WTRU may be used in conjunction with modules, implemented in hardware and/or software, such as a camera, a video camera module, a videophone, a speakerphone, a vibration device, a speaker, a microphone, a television transceiver, a hands free headset, a keyboard, a Bluetooth® module, a frequency modulated (FM) radio unit, a liquid crystal display (LCD) display unit, an organic light-emitting diode (OLED) display unit, a digital music player, a media player, a video game player module, an Internet browser, and/or any wireless local area network (WLAN) module.

[0032] EMBODIMENTS

1. In a wireless network having at least two users, a method comprising:
initially establishing a circuit switched (CS) session between two users having different content capabilities;
establishing a IP Multimedia subsystem (IMS) session between the two users;
combining the CS session and the IMS session; and
providing interworking of the combined CS and IMS session.
2. The method of embodiment 1, wherein the content includes at least voice and multimedia.

3. The method of embodiments 1 and 2, wherein a first one of the two users invites the IMS session.
4. The method of embodiments 1-3, wherein a second one of the two users accepts the IMS invitation.
5. The method of embodiments 1-4, wherein the CS and IMS content is combined in the IMS domain using a CSI interworking function (IWF).
6. The method of embodiments 1-5, further comprising configuring one of the two users as a wireless transmit/receive unit (WTRU) having Internet Protocol (IP) multimedia system (IMS) capabilities.
7. The method of embodiments 1-6, further comprising configuring one of the two users as a wireless transmit/receive unit (WTRU) having interworking Internet Protocol (IP) multimedia system (IMS) and circuit switched (CS) call capabilities.
8. The method of embodiments 1-7, further comprising configuring a remaining one of the two users as a wireless transmit/receive unit (WTRU) having interworking Internet Protocol (IP) multimedia system (IMS) and circuit switched (CS) call capabilities.
9. The method of embodiments 1-8, further comprising the WTRU having Internet Protocol (IP) multimedia system (IMS) capabilities initiating an invite for a combined CS and IMS session.
10. The method of embodiments 1-9, further comprising the WTRU having interworking capabilities receiving a voice message over the CS capability and receiving media content over the IMS capability.

11. The method of embodiments 1-10, further comprising the WTRU having IMS capabilities receiving a Voice over IP (VoIP) voice message combined with a media message over the IMS capability.

12. The method of embodiments 1-11, further comprising providing an interworking function between said two users for receiving media and VoIP format voice content from the IMS capable WTRU and providing media content to the IMS capability of the interworking WTRU and translating VoIP format voice content to a format compatible with the CS capability of the interworking WTRU.

13. The method of embodiments 1-12, further comprising providing an interworking function between said two users for receiving media and a CS voice content from the interworking WTRU and providing media content to the IMS capability of the IMS capable WTRU and translating the CS voice content to VoIP format compatible with the IMS capability of the IMS capable WTRU.

14. The method of embodiments 1-13, further comprising providing an interworking function (IWF) between said two users for conveying to only the IMS capability of the interworking WTRU an invite from the IMS capable WTRU, conveyed to the IWF through an IMS domain and receiving an accept from the interworking WTRU and conveying the Accept to the IMS capable WTRU through the IMS domain.

15. The method of embodiments 1-14, further comprising the (IWF) establishing CS voice bearer between a media gateway (MGW) in said IMS domain and the CS capability of the interworking WTRU.

16. The method of embodiments 1-15, further comprising the (IWF) establishing a packet switched (PS) media bearer between said IMS capability of the interworking WTRU and the IMS domain.

17. In a wireless network having at least two users, apparatus comprising:
a device for initially establishing a circuit switched (CS) session between two users having different content capabilities;

said device further establishing a IP Multimedia subsystem (IMS) session between the two users by combining the CS session and the IMS session, thereby providing interworking of the combined CS and IMS session.

18. The apparatus of embodiment 17, wherein the content includes at least voice and multimedia.

19. The apparatus of embodiments 17 and 18, wherein a first one of the two users is configured to provide an invite for the IMS session.

20. The apparatus of embodiments 17-19, wherein a second one of the two users is configured to respond to the invite and send an accept of the IMS invitation.

21. The apparatus of embodiments 17-20, wherein the CS and IMS content is combined in the IMS domain using a CSI interworking function (IWF).

22. The apparatus of embodiments 17-21, further comprising one of the two users being configured as a wireless transmit/receive unit (WTRU) having Internet Protocol (IP) multimedia system (IMS) capabilities.

23. The apparatus of embodiments 17-22, further comprising one of the two users being configured as a wireless transmit/receive unit (WTRU) having interworking Internet Protocol (IP) multimedia system (IMS) and circuit switched (CS) call capabilities.

24. The apparatus of embodiments 17-23, further comprising a remaining one of the two users being configured as a wireless transmit/receive unit (WTRU)

having interworking Internet Protocol (IP) multimedia system (IMS) and circuit switched (CS) call capabilities.

25. The apparatus of embodiments 17-24, further comprising the WTRU having Internet Protocol (IP) multimedia system (IMS) capabilities being configured to initiate an invite for a combined CS and IMS session.

26. The apparatus of embodiments 17-25, further comprising the WTRU having interworking capabilities being configured to receive a voice message over the CS capability and to receive media content over the IMS capability.

27. The apparatus of embodiments 17-26, further comprising the WTRU having IMS capabilities being configured to receive a Voice over IP (VoIP) voice message combined with a media message over the IMS capability.

28. The apparatus of embodiments 17-27, further comprising providing an interworking function between said two users configured to receive media and VoIP format voice content from the IMS capable WTRU and providing media content to the IMS capability of the interworking WTRU and configured to translate VoIP format voice content to a format compatible with the CS capability of the interworking WTRU.

29. The apparatus of embodiments 17-28, further comprising providing an interworking function between said two users configured to receive media and a CS voice content from the interworking WTRU and providing media content to the IMS capability of the IMS capable WTRU and configured to translate the CS voice content to VoIP format compatible with the IMS capability of the IMS capable WTRU.

30. The apparatus of embodiments 17-29 further comprising providing an interworking function (IWF) between said two users configured to convey to only the

IMS capability of the interworking WTRU an invite from the IMS capable WTRU, conveyed to the IWF through an IMS domain and configured to receive an accept from the interworking WTRU and conveying the Accept to the IMS capable WTRU through the IMS domain.

31. The apparatus of embodiments 17-30, further comprising the (IWF) being configured to establish a CS voice bearer between a media gateway (MGW) in said IMS domain and the CS capability of the interworking WTRU.

32. The apparatus of embodiments 17-31, further comprising the (IWF) being configured to establish a packet switched (PS) media bearer between said IMS capability of the interworking WTRU and the IMS domain.

33. The apparatus of embodiments 17-32, further comprising the (IWF) being configured to convey terminate messages to the interworking WTRU and the MGW responsive to a terminate (BYE) message from the IMS capable WTRU.

34. The apparatus of embodiments 17-33, further comprising the MGW being configured to provide a release call message to interworking WTRU responsive to the BYE message from the IWF.

35. A WTRU configured according to any of the embodiments 1 through 34.

36. A WTRU configured to function with any of the embodiments 1 through 34.

37. An interworking function (IWF) configured according to any of the embodiments 1 through 36.

38. An interworking function (IWF) configured to function with any of the embodiments 1 through 36.

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CLAIMS

What is claimed is:

1. In a wireless network having at least two users, a method comprising:
initially establishing a circuit switched (CS) session between two users having different content capabilities;
establishing an IP Multimedia subsystem (IMS) session between the two users;
combining the CS session and the IMS session; and
providing interworking of the combined CS and IMS session.
2. The method of claim 1, wherein the content includes at least voice and multimedia.
3. The method of claim 1, wherein a first one of the two users invites the IMS session.
4. The method of claim 1, wherein a second one of the two users accepts the IMS invitation.
5. The method of claim 4, wherein the CS and IMS content is combined in the IMS domain using a CSI interworking function (IWF).
6. The method of claim 1, further comprising configuring one of the two users as a wireless transmit/receive unit (WTRU) having Internet Protocol (IP) multimedia system (IMS) capabilities.
7. The method of claim 1, further comprising configuring one of the two users as a wireless transmit/receive unit (WTRU) having interworking Internet Protocol (IP) multimedia system (IMS) and circuit switched (CS) call capabilities.

8. The method of claim 7, further comprising configuring a remaining one of the two users as a wireless transmit/receive unit (WTRU) having interworking Internet Protocol (IP) multimedia system (IMS) and circuit switched (CS) call capabilities.

9. The method of claim 8, further comprising the (WTRU) having Internet Protocol (IP) multimedia system (IMS) capabilities initiating an invite for a combined CS and IMS session.

10. The method of claim 8, further comprising the (WTRU) having interworking capabilities-receiving a voice message over the CS capability and receiving media content over the IMS capability.

11. The method of claim 10, further comprising the (WTRU) having IMS capabilities receiving a Voice over IP (VoIP) voice message combined with a media message over the IMS capability.

12. The method of claim 8, further comprising providing an interworking function between said two users for receiving media and VoIP format voice content from the IMS capable WTRU and providing media content to the IMS capability of the interworking WTRU and translating VoIP format voice content to a format compatible with the CS capability of the interworking WTRU.

13. The method of claim 8, further comprising providing an interworking function between said two users for receiving media and a CS voice content from the interworking WTRU and providing media content to the IMS capability of the IMS capable WTRU and translating the CS voice content to VoIP format compatible with the IMS capability of the IMS capable WTRU.

14. The method of claim 8, further comprising providing an interworking function (IWF) between said two users for conveying to only the IMS capability of

the interworking WTRU an invite from the IMS capable WTRU, conveyed to the IWF through an IMS domain and receiving an accept from the interworking WTRU and conveying the Accept to the IMS capable WTRU through the IMS domain.

15. The method of claim 14, further comprising the (IWF) establishing CS voice bearer between a media gateway (MGW) in said IMS domain and the CS capability of the interworking WTRU.

16. The method of claim 14, further comprising the (IWF) establishing a packet switched (PS) media bearer between said IMS capability of the interworking WTRU and the IMS domain.

17. In a wireless network having at least two users, an apparatus comprising:

a device for initially establishing a circuit switched (CS) session between two users having different content capabilities;

said device further establishing an IP Multimedia subsystem (IMS) session between the two users by combining the CS session and the IMS session, thereby providing interworking of the combined CS and IMS session.

18. The apparatus of claim 17, wherein the content includes at least voice and multimedia.

19. The apparatus of claim 17, wherein a first one of the two users is configured to provide an invite for the IMS session.

20. The apparatus of claim 17, wherein a second one of the two users is configured to respond to the invite and send an accept of the IMS invitation.

21. The apparatus of claim 20, wherein the CS and IMS content is combined in the IMS domain using a CSI interworking function (IWF).

22. The apparatus of claim 17, further comprising one of the two users being configured as a wireless transmit/receive unit (WTRU) having Internet Protocol (IP) multimedia system (IMS) capabilities.

23. The apparatus of claim 17, further comprising one of the two users being configured as a wireless transmit/receive unit (WTRU) having interworking Internet Protocol (IP) multimedia system (IMS) and circuit switched (CS) call capabilities.

24. The apparatus of claim 23, further comprising a remaining one of the two users being configured as a wireless transmit/receive unit (WTRU) having interworking Internet Protocol (IP) multimedia system (IMS) and circuit switched (CS) call capabilities.

25. The apparatus of claim 24, further comprising the (WTRU) having Internet Protocol (IP) multimedia system (IMS) capabilities being configured to initiate an invite for a combined CS and IMS session.

26. The apparatus of claim 24, further comprising the (WTRU) having interworking capabilities being configured to receive a voice message over the CS capability and to receive media content over the IMS capability.

27. The apparatus of claim 26, further comprising the (WTRU) having IMS capabilities being configured to receive a Voice over IP (VoIP) voice message combined with a media message over the IMS capability.

28. The apparatus of claim 24, further comprising providing an interworking function between said two users configured to receive media and VoIP format voice content from the IMS capable WTRU and providing media content to the IMS capability of the interworking WTRU and configured to translate VoIP

format voice content to a format compatible with the CS capability of the interworking WTRU.

29. The apparatus of claim 24, further comprising providing an interworking function between said two users configured to receive media and a CS voice content from the interworking WTRU and providing media content to the IMS capability of the IMS capable WTRU and configured to translate the CS voice content to VoIP format compatible with the IMS capability of the IMS capable WTRU.

30. The apparatus of claim 24 further comprising providing an interworking function (IWF) between said two users configured to convey to only the IMS capability of the interworking WTRU an invite from the IMS capable WTRU, conveyed to the IWF through an IMS domain and configured to receive an accept from the interworking WTRU and conveying the Accept to the IMS capable WTRU through the IMS domain.

31. The apparatus of claim 30, further comprising the (IWF) being configured to establish a CS voice bearer between a media gateway (MGW) in said IMS domain and the CS capability of the interworking WTRU.

32. The apparatus of claim 30, further comprising the (IWF) being configured to establish a packet switched (PS) media bearer between said IMS capability of the interworking WTRU and the IMS domain.

33. The apparatus of claim 29, further comprising the (IWF) being configured to convey terminate messages to the interworking WTRU and the MGW responsive to a terminate (BYE) message from the IMS capable WTRU.

34. The apparatus of claim 33, further comprising the MGW being configured to provide a release call message to interworking WTRU responsive to the BYE message from the IWF.