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(54) **BI-DIRECTIONAL AND REVERSE DIRECTIONAL RESOURCE RESERVATION SETUP PROTOCOL**

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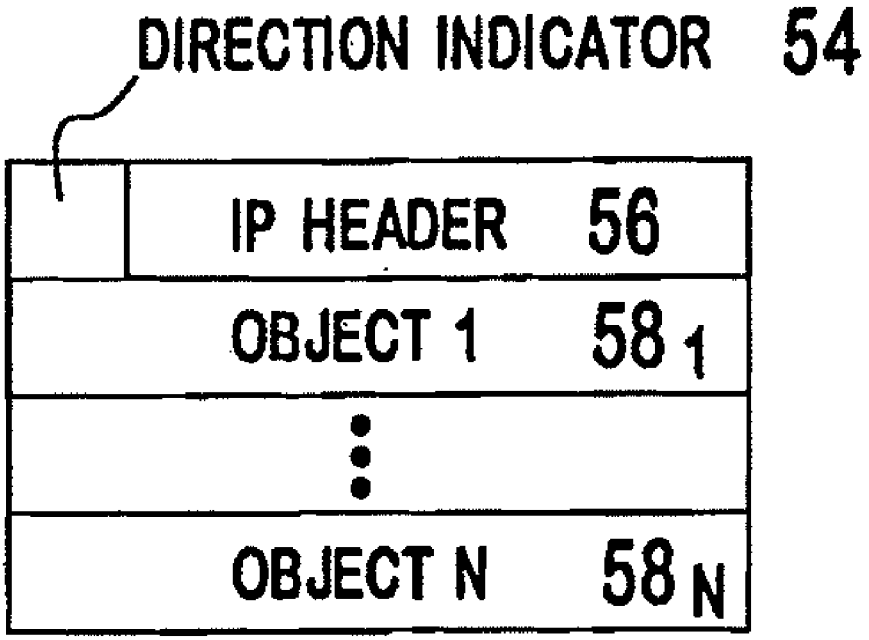
(52) **U.S. Cl.**

CPC ***H04L 47/724*** (2013.01); ***H04L 69/22*** (2013.01); ***H04L 47/824*** (2013.01); *H04W 72/0406* (2013.01)

(57) **ABSTRACT**

A method, system and apparatus for resource reservation are disclosed herein. In an example, a first router may transmit, to a second router, a path message comprising an indication of resources to be reserved and a bidirectional direction indicator. On a condition that the indicated resources to be reserved are available to the second router, the first router may receive, from the second router, a reserve message, which may indicate that transmission resources have been allocated by the second router. On a condition that the indicated resources to be reserved are not available to the second router, first router may receive, from the second router, an error message, which may indicate that transmission resources have not been allocated. In a further example, the resources to be reserved may be resources associated with voice traffic, video traffic or both. Voice traffic may include multiple party communications involving three or more users.



Prior Art

FIG. 1

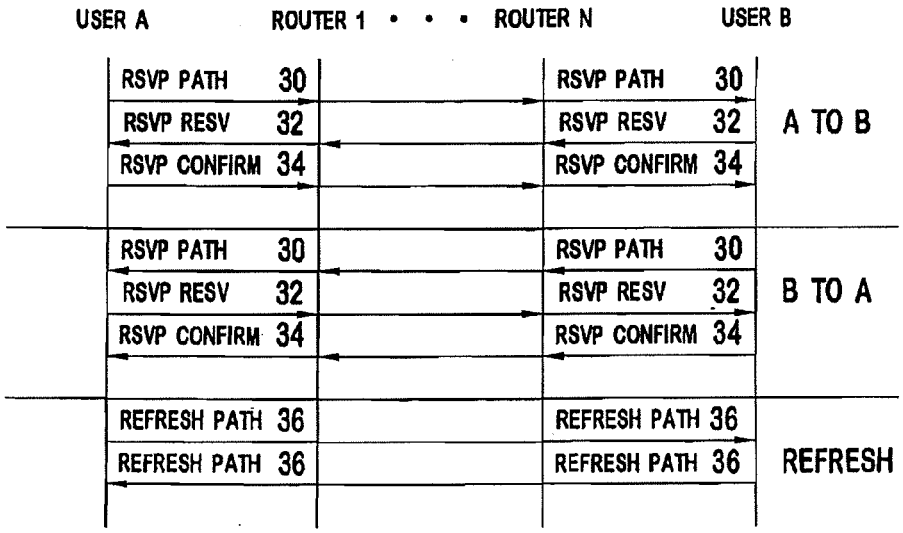


FIG. 2

Prior Art

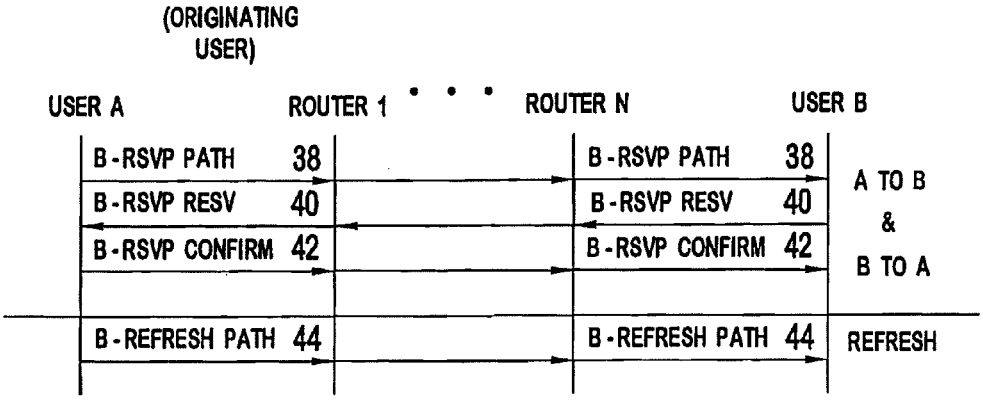


FIG. 3

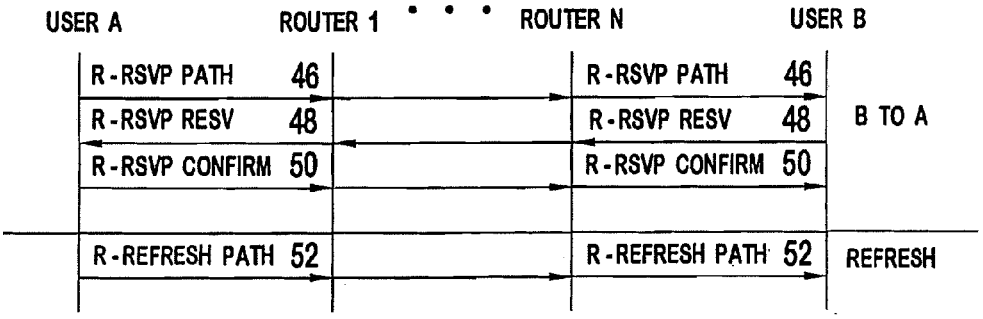


FIG. 4

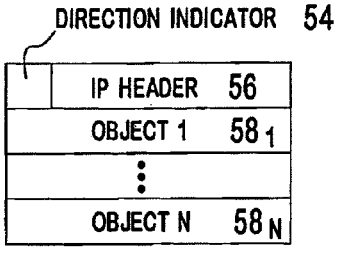


FIG. 5

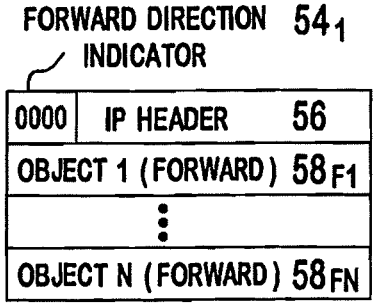


FIG. 6

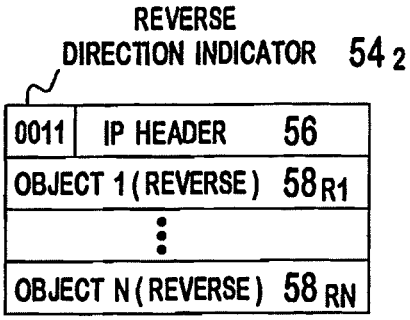


FIG. 7

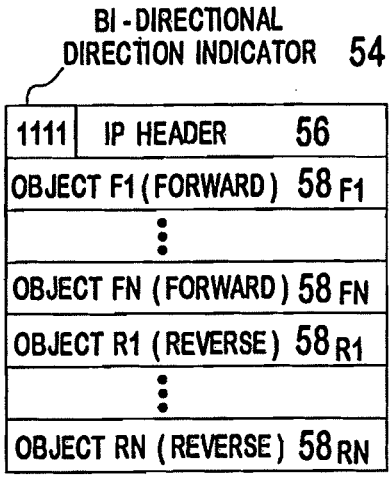


FIG. 8

```
<PATH MESSAGE> :: = <COMMON HEADER> [ <INTEGRITY> ]
                                    <SESSION> <RSVP_HOP>
                                      <TIME_VALUES>
                                     [ <POLICY_DATA> ... ]
                                     [ <SENDER DESCRIPTOR> ]
<SENDER DESCRIPTOR> : : = <SENDER_TEMPLATE> < SENDER_TSPEC >
                                     [ <ADSPEC> ]
```

FIG. 9

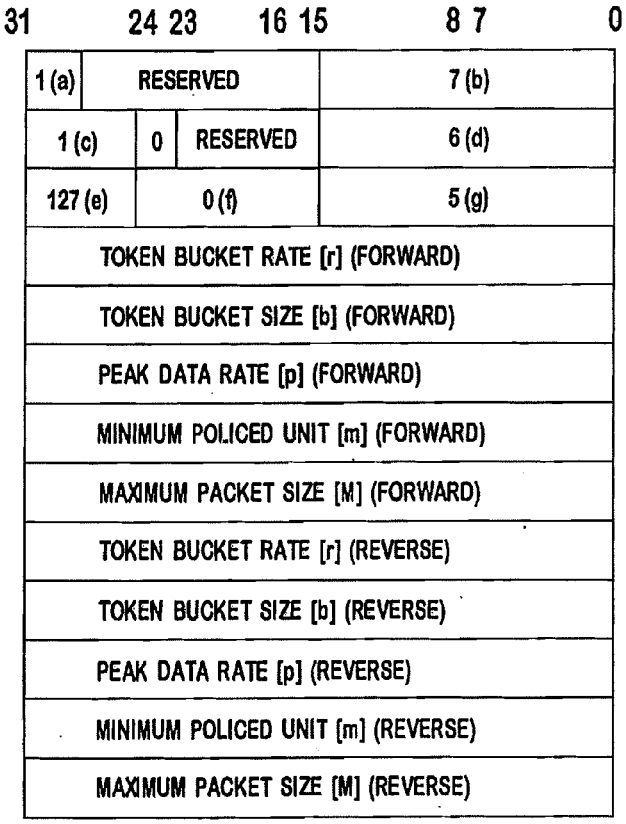


FIG. 10

31 24	23 16	15 8	7 0
1(c)	X	RESERVED	8(d)
4(e)	(f)		1(g)
IS HOP CNT (32-BIT UNSIGNED INTEGER)			
6(h)	(i)		1(j)
PATH b/w ESTIMATE (FORWARD)			
PATH b/w ESTIMATE (REVERSE)			
8(k)	(l)		1(m)
MINIMUM PATH LATENCY (FORWARD)			
MINIMUM PATH LATENCY (REVERSE)			
10(n)	(o)		1(p)
COMPOSED MTU (FORWARD)			
COMPOSED MTU (REVERSE)			

FIG. 11

31 24	23 16	15 8	7 0
2(c)	X	RESERVED	8(d)
4(e)	(f)		1(g)
END-TO-END COMPOSED VALUE FOR C[Ctot] (FORWARD)			
END-TO-END COMPOSED VALUE FOR C[Ctot] (REVERSE)			
134(f)	(g)		1(h)
END-TO-END COMPOSED VALUE FOR D[Dtot] (FORWARD)			
END-TO-END COMPOSED VALUE FOR D[Dtot] (REVERSE)			
135(i)	(j)		1(k)
SINCE-LAST-RESHAPING POINT COMPOSED C[Csum] (FORWARD)			
SINCE-LAST-RESHAPING POINT COMPOSED C[Csum] (REVERSE)			
136(l)	(m)		1(n)
SINCE-LAST-RESHAPING POINT COMPOSED D[Dsum] (FORWARD)			
SINCE-LAST-RESHAPING POINT COMPOSED D[Dsum] (REVERSE)			
SERVICE-SPECIFIC GENERAL PARAMETER/VALUE IF PRESENT			

FIG. 12

```
<RESV MESSAGE> :: = <COMMON HEADER> [ <INTEGRITY> ]
                        <SESSION>  <RSVP_HOP>
                                <TIME_VALUES>
                                [ <RESV_CONFIRM> ]  [ <SCOPE> ]
                                [ <POLICY_DATA> ... ]
                                <STYLE> <FLOW DESCRIPTOR LIST>
        <FLOW DESCRIPTOR LIST> : : =  <EMPTY>
                        <FLOW DESCRIPTOR LIST> <FLOW DESCRIPTOR>
```

FIG. 13

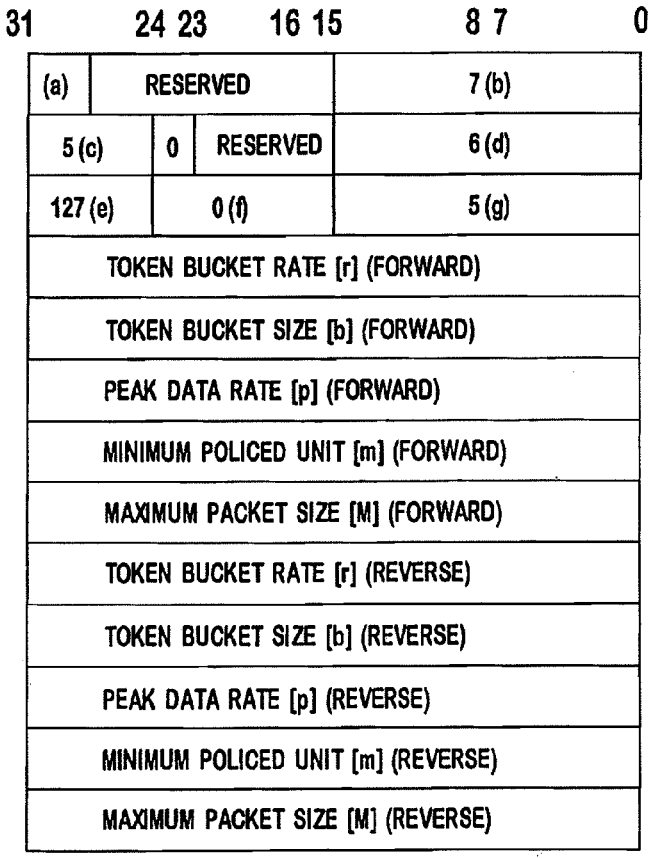


FIG. 14

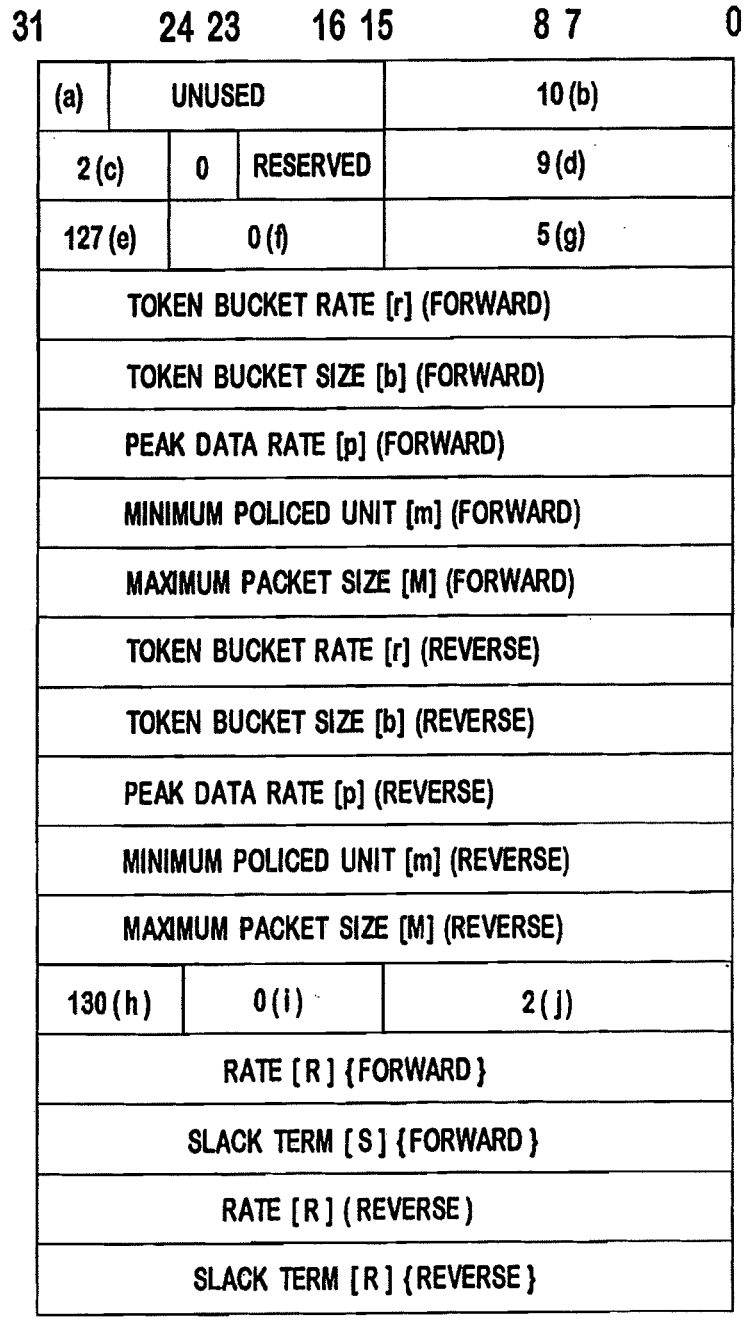

31
24 23
16 15
8 7
0
(a)
UNUSED
10 (b)
2 (c)
0
RESERVED
9 (d)
127 (e)
0 (f)
5 (g)
TOKEN BUCKET RATE [r] (FORWARD)
TOKEN BUCKET SIZE [b] (FORWARD)
PEAK DATA RATE [p] (FORWARD)
MINIMUM POLICED UNIT [m] (FORWARD)
MAXIMUM PACKET SIZE [M] (FORWARD)
TOKEN BUCKET RATE [r] (REVERSE)
TOKEN BUCKET SIZE [b] (REVERSE)
PEAK DATA RATE [p] (REVERSE)
MINIMUM POLICED UNIT [m] (REVERSE)
MAXIMUM PACKET SIZE [M] (REVERSE)
130 (h)
0 (i)
2 (j)
RATE [R] {FORWARD}
SLACK TERM [S] {FORWARD}
RATE [R] (REVERSE)
SLACK TERM [R] {REVERSE}

FIG. 15

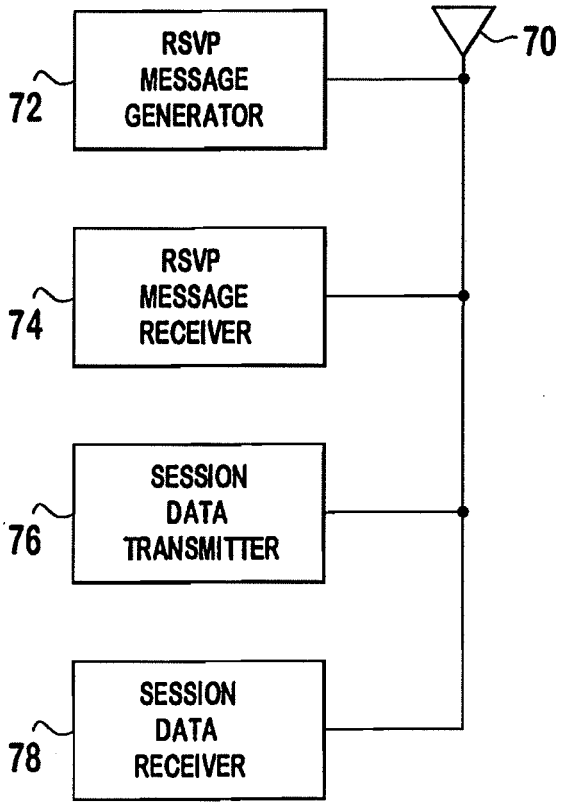

RSVP MESSAGE GENERATOR
72
RSVP MESSAGE RECEIVER
74
SESSION DATA TRANSMITTER
76
SESSION DATA RECEIVER
78
70

FIG. 16

BI-DIRECTIONAL AND REVERSE DIRECTIONAL RESOURCE RESERVATION SETUP PROTOCOL

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 14/708,988 filed May 11, 2015, which is a continuation of U.S. patent application Ser. No. 14/138,767 filed Dec. 23, 2013, which issued as U.S. Pat. No. 9,030,933 on May 12, 2015, which is a continuation of U.S. patent application Ser. No. 13/312,021 filed Dec. 6, 2011, which issued as U.S. Pat. No. 8,630,176 on Jan. 14, 2014, which is a continuation of U.S. patent application Ser. No. 12/170,825 filed Jul. 10, 2008, which issued as U.S. Pat. No. 8,085,664 on Dec. 27, 2011, which is a continuation of U.S. patent application Ser. No. 10/288,065 filed Nov. 4, 2002, which issued as U.S. Pat. No. 7,400,582 on Jul. 15, 2008, which claims the benefit of U.S. Provisional Application Ser. No. 60/336,304 filed Nov. 2, 2001, the contents of which are hereby incorporated by reference herein.

FIELD OF INVENTION

[0002] The present invention relates to wireless packet based communications. In particular, the invention relates to establishing wireless packet based communications.

BACKGROUND

[0003] For certain Internet applications, resources are reserved to achieve the necessary quality of service (QOS). The reservation of resources allows packet based networks to operate like circuit switched networks. FIG. **1** is an illustration of a simplified wireless packet based, such as Internet based, communication session, such as for wireless Internet, wireless multimedia, voice over Internet Protocol, video conferencing or video telephony, between two wireless users, user A and user B. Differing sessions have differing performance requirements, such as setup time, delay, reliability, integrity and quality of service (QOS). User A is shown as user equipment (UE) **20** and user B is shown as UE **22**. User A sends and receives communicates via the packet network **28** using its cellular network **24**. User B similarly sends and receives communications via the packet network **28** using its cellular network **26**.

[0004] FIG. **2** is an illustration of establishing such a session. User A sends a resource reservation setup protocol (RSVP) PATH message **30** to establish the session. The RSVP PATH message **30** is sent to user B via various network routers (Router 1-Router N). Each router determines whether the resources are available for the session. If adequate resources are available, the RSVP PATH message **30** is updated and passed to the next router. If adequate resources are not available, an error message is sent back to user A. When user B receives the RSVP PATH message **30**, user B responds by sending a RSVP reservation (RESV) message **32** to reserve the resources throughout the networks **24**, **26**, **28**. As the RSVP RESV message **32** is sent through the networks, resources are allocated to support the communications from user A to user B. If the resources are successfully allocated, user A receives the RSVP RESV message **32**. User A sends a confirmation (RSVP confirm) message **34** to user B to acknowledge receipt of the RSVP RESV message **32**.

[0005] To allocate resources for user B's communications to user A, user B sends a RSVP PATH message **30** to user A via various network routers (Router 1-Router N). When user A receives the RSVP PATH message **30**, user A responds by sending a RSVP RESV message **32** to reserve the resources throughout the networks **24**, **26**, **28**. As the RSVP RESV message **32** is sent through the networks **24**, **26**, **28**, resources are allocated to support the communications from user B to user A. If the resources are successfully allocated, user B receives the RESV message **32**. User B sends a RSVP confirm message **34** to user A to acknowledge receipt of the RSVP RESV message **34**.

[0006] To maintain the resource allocations, Refresh PATH messages **36** are periodically sent through the networks **24**, **26**, **28**. User A sends Refresh PATH messages **36** through the networks **24**, **26**, **28** to user B to maintain the resources for user A's transmissions and user B sends Refresh PATH messages **36** through the networks **24**, **26**, **28** to user A to maintain the resources for user B's transmissions. If the Refresh PATH messages **36** are not sent, the reservation states will expire with the allocated resources being released.

[0007] Sending all these messages to allocate resources uses valuable network resources. Accordingly, it is desirable to have alternate approaches to establishing wireless Internet sessions.

SUMMARY

[0008] A wireless user equipment (UE) configured to initiate a packet based session is disclosed. The UE includes a reservation setup protocol (RSVP) message generator configured to transmit a RSVP PATH message. The RSVP PATH message includes a direction indication. The direction indicator indicates that reservations should be made for the UE to transmit only, to receive only or to both transmit and receive. The UE also includes an RSVP message receiver configured to receive an RSVP RESV message indicating that reservations have been made as a result of the RSVP PATH message.

[0009] A method, system and apparatus for resource reservation are disclosed herein. In an example, a first router may transmit, to a second router, a path message comprising an indication of resources to be reserved and a bidirectional direction indicator. On a condition that the indicated resources to be reserved are available to the second router, the first router may receive, from the second router, a reserve message. The reserve message may indicate that transmission resources have been allocated by the second router.

[0010] On a condition that the indicated resources to be reserved are not available to the second router, first router may receive, from the second router, an error message. The error message may indicate that transmission resources have not been allocated.

[0011] In a further example, the resources to be reserved may be resources associated with voice traffic, video traffic or both. The voice traffic may include multiple party communications involving three or more users. In an example, the first router and the second router may be wired routers. In another example, the path message may include resource allocation information for both communications transmitted from the first router to the second router and from the second router to the first router.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is an illustration of simplified wireless packet based communication system.

[0013] FIG. **2** is an illustration of establishing a wireless packet session.

[0014] FIG. **3** is an illustration of establishing a wireless packet session using bi-directional reservation setup protocol.

[0015] FIG. **4** is an illustration of establishing a wireless packet session using reverse direction reservation setup protocol.

[0016] FIG. **5** is a simplified illustration of a preferred reservation setup message.

[0017] FIG. **6** is a simplified illustration of a preferred forward direction reservation setup message.

[0018] FIG. **7** is a simplified illustration of a preferred reverse direction reservation setup protocol message.

[0019] FIG. **8** is a simplified illustration of a preferred bi-directional reservation setup protocol message.

[0020] FIG. **9** is an illustration of a preferred bi-directional reservation setup protocol PATH message.

[0021] FIG. **10** is an illustration of the SENDER_TSPEC of FIG. **9**.

[0022] FIGS. **11** and **12** are illustrations of the ADSPEC of FIG. **9**.

[0023] FIG. **13** is an illustration of a preferred bi-directional reservation setup protocol reservation message.

[0024] FIGS. **14** and **15** are illustrations of FLOWSPECs of the bi-directional reservation setup protocol reservation message of FIG. **13**.

[0025] FIG. **16** is a simplified block diagram of a wireless user equipment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0026] FIG. **3** is an illustration of bi-directional resource reservation setup protocol. User A desires to setup a bi-directional packet based, such as Internet, session with user B. The requirements, such as bit rate and relative delay, for the session are based on prior negotiations. Both users A and B may be wireless users or one of the two is a wireless user and the other is a wired user. To initiate the session, user A (the originating user) sends a bi-directional RSVP PATH message **38**. The bi-directional RSVP PATH message **38** contains resource allocation information for both the communications transmitted from user A to user B and from user B to user A. The preferred format of these communications is discussed in more detail in conjunction with FIGS. **8**, **9**, **10**, **11** and **12**. Although the invention is described primarily in conjunction with two-direction communications, the invention is extendable to any multiple party communications, such as three-way calling.

[0027] The bi-directional RSVP PATH message **38** is send through the various routers (Router 1-Router N) of the networks to user B. User B sends a bi-directional RSVP RESV message **40** to allocate the resources for both users through the networks **24**, **26**, **28**. A preferred bi-directional RSVP RESV message **40** is described in more detail in conjunction with FIGS. **8**, **13**, **14** and **15**. Upon transferring the bi-directional RSVP RESV message **40**, each network allocates the resources for both user A's and user B's transmissions. Upon receiving the bi-directional RSVP RESV message **40**, indicating that the resources have been successfully allocated, user A sends a bi-directional RSVP confirm message **42** to user B through the networks. Upon receiving the bi-directional RSVP confirm message **42**, bi-direction communication between users A and B begins. Preferably, the originating user, user A, is responsible for the session, such as for billing purposes. Making the originating user responsible for the session simplifies billing procedures.

[0028] To maintain the resource allocations, periodically, bi-directional Refresh PATH messages **44** are sent by user A through the networks to user B. Upon transferring the bi-directional Refresh PATH messages **44**, the networks maintain the resource allocations for both directions.

[0029] Using the bi-directional messages reduces overhead required for the establishment of the session. Instead of both user A and user B sending RSVP PATH **30**, RSVP RESV **32** and RSVP confirm **34** messages, only one user sends bi-directional messages. Although the information carried by each of these messages is typically increased, by reducing the number of messages, the overall network overhead is decreased. Additionally, the bi-directional messaging avoids call scenarios, where the resources in one direction are established and the resources in the other direction are not. The reduced overhead lessens the impact on air resources and improves network performance.

[0030] FIG. **4** is an illustration of reverse resource reservation setup protocol. User A desires to setup an Internet session where only user B transmits information. Both users A and B may be wireless users or one of the two is a wireless user and the other is a wired user. To initiate the session, user A (the originating user) sends a reverse direction RSVP PATH message **46**. The reverse direction RSVP PATH message **46** contains resource allocation information for user B's transmissions to user A.

[0031] The reverse direction RSVP PATH message **46** is sent through the various routers (Router 1-Router N) of the networks to user B. User B sends a reverse direction RSVP RESV message **48** to allocate the resources for its transmission. Upon receiving the reverse direction RSVP RESV message **48**, user A sends a reverse direction RSVP confirm message **50** to user B through the networks **24**, **26**, **28**. Upon receiving the reverse direction RSVP confirm message **50**, user B begins transferring data to user A. Preferably, user A (although user A is not transmitting any substantive information) is responsible for the session.

[0032] FIG. **5** is an illustration of a simplified preferred RSVP message, illustrating generically the RSVP PATH, RSVP RESV and RSVP confirm messages. The preferred message has an IP header having a direction indicator, (forward, reverse and bi-directional) and having objects $\mathbf{58}_1$-$\mathbf{58}_N$. Preferably, the message is based on and is backward compatible with RFC 2205 and the direction indicator is a four bit indicator. For RFC 2205, the four bits of the direction indicator **541** are assigned the value "0000" for the forward direction (the originating user only sends information). A preferred forward direction RSVP message is shown in FIG. **6**, with only objects $\mathbf{58}_{F1}$-$\mathbf{58}_{FN}$ for the forward direction, "(FORWARD)", being included. In RFC 2205, each user (each of users A and B) is an originating user. A value "0011" for the direction indicator **542** indicates the reverse direction (the originating user only receives information). A preferred reverse direction RSVP message is shown in FIG. **7**. In FIG. **7**, all of the objects $\mathbf{58}_{R1}$-$\mathbf{58}_{RN}$ are for the reverse direction, "(REVERSE)". A value "1111" for

the direction indicator $\mathbf{54}_3$ indicates both directions are used (the originating user will receive and send). A preferred bi-directional RSVP message is shown in FIG. **8**. In FIG. **8**, both "(FORWARD)" $\mathbf{58}_{F1}$-$\mathbf{58}_{FN}$ and "(REVERSE)" $\mathbf{58}_{R1}$-$\mathbf{58}_{RN}$ objects are present.

[0033] FIG. **9** is an illustration of a preferred bi-directional RSVP PATH message compatible with RFC 2205. The bi-directional RSVP PATH message has fields for the "<Path Message>", "<Common Header>", "<INTEGRITY>", "<SESSION>", "<RSVP_HOP>", "<TIME_VALUES>", "<POLICY_DATA>", "<sender description>", "<sender descriptor>", "<SENDER_TEMPLATE>", "<SENDER_TSPEC>" and "<ADSPEC>".

[0034] FIG. **10** is an illustration of a "<SENDER_TSPEC>". Along the top of the figure are numbers indicating the bit positions from bit position 0 to 31. As shown in FIG. **10** for a bi-directional RSVP PATH message, both "(Forward)" and "(Reverse)" information is included.

[0035] Two illustrations of the "<ADSPEC>" field are shown in FIGS. **11** and **12**. FIG. **11** illustrates a PATH Default ADSPEC and FIG. **12** illustrates a PATH Guaranteed Service ADSPEC. As shown in those figures, both ADSPECs contain both forward and reverse information.

[0036] FIG. **13** is an illustration of a preferred bi-directional RSVP RESV message compatible with RFC 2205. The bi-directional RSVP RESV message has fields for "<Resv Message>", "<Common Header>", "<INTEGRITY>", "<SESSION>", "<RSVP_HOP>", "<TIME_VALUES>", "<RESV_CONFIRM>", "<SCOPE>", "<POLICY_DATA>", "<STYLE>", "<flow descriptor list>" and "<flow descriptor>".

[0037] The direction indicator is included in the "<flow descriptor list>". Two illustrations of preferred FLOWSPECs of the "<flow descriptor list>" are shown in FIGS. **14** and **15**. FIG. **14** is a FLOWSPEC for Guaranteed service and FIG. **15** is a FLOWSPEC for Guaranteed Service Extension Format. As shown in FIGS. **14** and **15** for a bi-directional RSVP RESV message, both forward and reverse direction information is carried by the message.

[0038] FIG. **16** is a block diagram of a wireless user equipment for use in bi-directional, reverse direction and forward direction reservation setup protocol messaging. An RSVP message generator **72** produces the RSVP PATH messages (including bi-directional RSVP and reverse direction RSVP PATH messages), RSVP RESV messages (including bi-directional RSVP and reverse direction RSVP RESV messages), RSVP Confirm messages (including bi-directional RSVP and reverse direction RSVP Confirm messages) and Refresh PATH messages (including bi-directional and reverse direction Refresh Path messages). An RSVP message receiver **74** is used to receive the various RSVP messages. The messages that the UE transmits or receives is based on the whether the UE is the originating user or non-originating user, as previously described. Session data is transmitted and received using a session data transmitter **76** and a session data receiver **78**. An antenna **70** or antenna array are used to radiate and receive the various messages and communications across the air interface.

What is claimed is:

1. A method for reserving resources in a network, the method comprising:

transmitting, by a router, a path message comprising a bidirectional direction indicator and an indication of resources to be reserved; and

receiving by the router, one of a reserve message or an error message, wherein the reserve message indicates that transmission resources have been allocated and the error message indicates that transmission resources have not been allocated.

2. The method of claim **1**, wherein the resources to be reserved are resources associated with voice traffic.

3. The method of claim **1**, wherein the resources to be reserved are resources associated with video traffic.

4. The method of claim **2**, wherein the voice traffic includes multiple party communications involving three or more users.

5. The method of claim **1**, wherein the router is wired router.

6. A method for reserving resources in a network, the method comprising:

transmitting, from a first router to a second router, a path message comprising an indication of resources to be reserved and a bidirectional direction indicator;

on a condition that the indicated resources to be reserved are available to the second router, receiving, by the first router from the second router, a reserve message, wherein the reserve message indicates that transmission resources have been allocated by the second router; and

on a condition that the indicated resources to be reserved are not available to the second router, receiving, by the first router from the second router, an error message, wherein the error message indicates that transmission resources have not been allocated.

7. The method of claim **6**, wherein the resources to be reserved are resources associated with voice traffic.

8. The method of claim **6**, wherein the resources to be reserved are resources associated with video traffic.

9. The method of claim **7**, wherein the voice traffic includes multiple party communications involving three or more users.

10. The method of claim **6**, wherein the first router and the second router are wired routers.

11. The method of claim **6**, wherein the path message includes resource allocation information for both communications transmitted from the first router to the second router and from the second router to the first router.

12. A method for reserving resources in a network, the method comprising:

receiving, by a router, a path message comprising an indication of resources to be reserved and a bidirectional direction indicator;

on a condition that the indicated resources to be reserved are available to the router, transmitting, by the router, a reserve message, wherein the reserve message indicates that transmission resources have been allocated by the router; and

on a condition that the indicated resources to be reserved are not available to the router, transmitting, by the router, an error message, wherein the error message indicates that transmission resources have not been allocated.

13. The method of claim **12**, wherein the resources to be reserved are resources associated with voice traffic.

14. The method of claim **12**, wherein the resources to be reserved are resources associated with video traffic.

15. The method of claim **13**, wherein the voice traffic includes multiple party communications involving three or more users.

16. The method of claim **12**, wherein the router is wired router.

17. A router comprising:

a transmitter, operatively coupled to a processor, the transmitter and the processor configured to transmit a path message comprising a bidirectional direction indicator and an indication of resources to be reserved; and

a receiver, operatively coupled to a processor, the receiver and the processor configured to receive one of a reserve message or an error message, wherein the reserve message indicates that transmission resources have been allocated and the error message indicates that transmission resources have not been allocated.

18. The router of claim **17**, wherein the resources to be reserved are resources associated with voice traffic.

19. The router of claim **17**, wherein the resources to be reserved are resources associated with video traffic.

20. The router of claim **18**, wherein the voice traffic includes multiple party communications involving three or more users.

21. The router of claim **17**, wherein the router is wired router.

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