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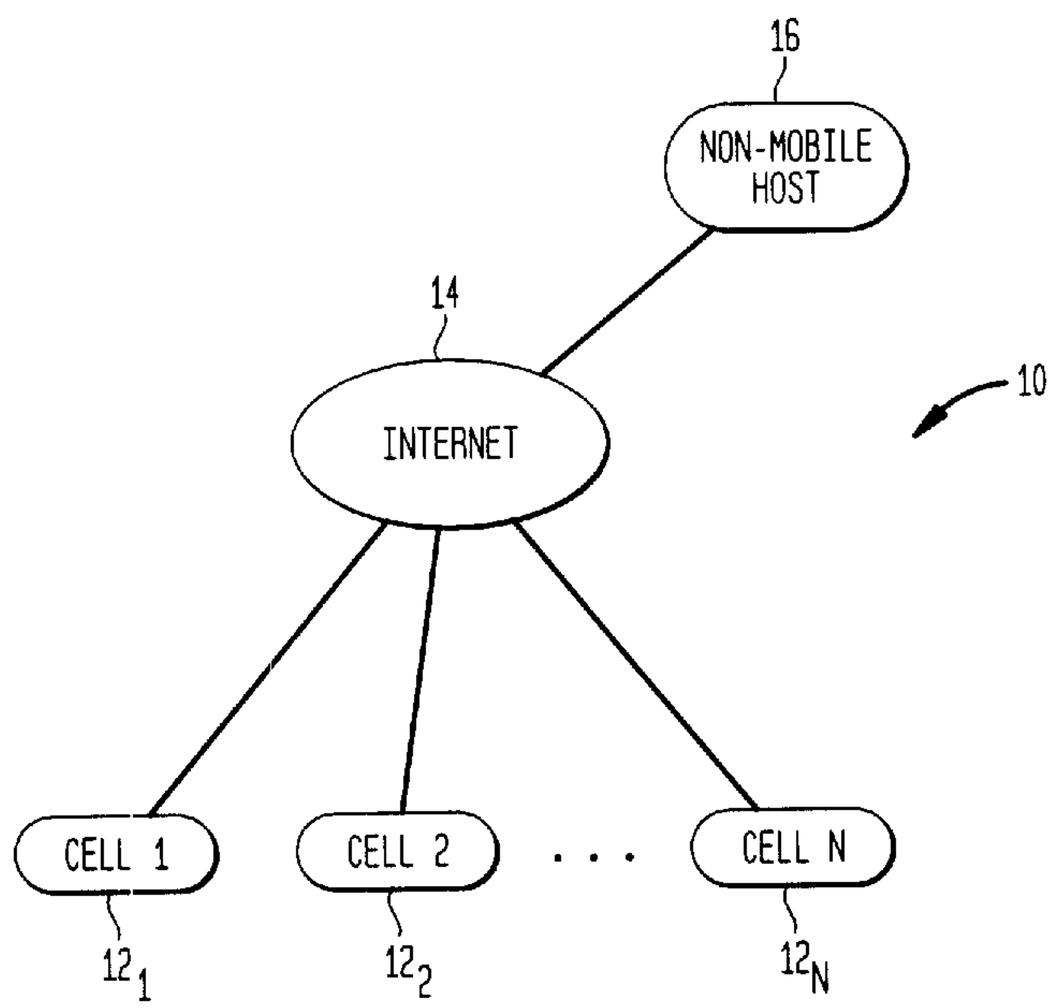
(54) **CONNEXION MOBILE/TCP ET METHODE D'ETABLISSEMENT ET DE MAINTIEN D'UNE CONNEXION MOBILE/TCP**

(54) **MOBILE-TCP AND METHOD OF ESTABLISHING AND MAINTAINING A MOBILE-TCP CONNECTION**



(57) A mobile TCP connection for mobile terminals/hosts (T/Hs) and a method for establishing and maintaining a mobile TCP connection while the IP addresses of the mobile T/Hs constantly change during the established mobile TCP connection. The method and device utilize a globally unique mobile TCP connection identification, which is included in every data segment communicated between the virtually connected mobile T/Hs, to always identify the mobile TCP connection. Using the mobile TCP connection identification, constantly changing IP addresses of the mobile T/Hs can be updated as the mobile T/Hs roam across the network.

MOBILE-TCP AND METHOD OF ESTABLISHING AND MAINTAINING A MOBILE-TCP CONNECTION

ABSTRACT:

A mobile TCP connection for mobile terminals/hosts (T/Hs) and a method for establishing and maintaining a mobile TCP connection while the IP addresses of the mobile T/Hs constantly change during the established mobile TCP connection. The method and device utilize a globally unique mobile TCP connection identification, which is included in every data segment communicated between the virtually connected mobile T/Hs, to always identify the mobile TCP connection. Using the mobile TCP connection identification, constantly changing IP addresses of the mobile T/Hs can be updated as the mobile T/Hs roam across the network.

MOBILE-TCP AND METHOD OF ESTABLISHING AND MAINTAINING A MOBILE-TCP CONNECTION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a mobile-TCP (m-TCP) and a method of establishing and maintaining an m-TCP connection between mobile terminals/hosts, e.g., computers, via the Internet or the like.

Description of Related Art

A TCP/IP (transmission control protocol/internet protocol) suite includes protocols that control communication between computers via the Internet. These protocols include a TCP, an IP, and a user datagram protocol (UDP). The TCP is a connection oriented service and the UDP is a connectionless service.

Conventionally, the TCP requires fixed IP endpoint addresses to establish a TCP connection between terminals/hosts (T/Hs). These IP endpoint addresses cannot be changed once the TCP connection has been established. That is, a TCP connection between two entities (e.g., T/Hs) is uniquely identified by a pair of endpoints. Each of the endpoints includes a two-tuple composed of an IP address of the host and a particular TCP port number within the host. These IP addresses and the TCP port numbers are fixed and unchangeable once the TCP connection has been established. However, for mobile T/Hs that roam through the network, such as the Internet, the endpoints constantly change. Therefore, conventional TCP services are inadequate for establishing and maintaining communication between mobile T/Hs.

SUMMARY OF THE INVENTION

The present invention is directed to providing an m-TCP connection for mobile T/Hs and a method for establishing and maintaining an m-TCP connection while the IP addresses of the mobile T/Hs constantly change during the established m-TCP

connection. The method and device utilize a globally unique m-TCP connection identification, which is included in every data segment communicated between the m-TCP connected mobile T/Hs, to always identify the m-TCP connection. Using the m-TCP connection identification, constantly changing IP addresses of the mobile T/Hs can be updated as the mobile T/Hs roam across the network.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, wherein reference numerals designate corresponding parts in the various drawings and wherein:

Fig. 1 shows a diagram of a communication system operating via the Internet according to an embodiment of the present invention;

Fig. 2 shows a structure of a cell in the communication system of Fig. 1; and

Fig. 3 shows an internal data structure of a TCP header according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following detailed description relates to an m-TCP and a method of establishing and maintaining an m-TCP connection according to the embodiments of the present invention. The m-TCP allows transmission of datagrams between mobile T/Hs (e.g., computers) virtually connected to each other via the Internet. A datagram is composed of a data segment and an IP header.

Fig. 1 shows a general diagram of a communication system operating via the Internet according to the present invention. As shown therein, the communication system 10 includes a plurality of cells 12_1, $12_2 \ldots 12_N$ and a non-mobile host 16, communicating via the Internet 14. These cells 12_1, $12_2 \ldots 12_N$ define a wireless access sub-network, i.e., an m-TCP/IP suite.

Each of the cells 12_1, $12_2 \ldots 12_N$ (cell 12) includes one Base Station (BS) 18 and a plurality of mobile T/Hs 20_1, $20_2 \ldots 20_N$, as shown in Fig. 2. The BS 18 provides radio

access to and from the plurality of mobile T/Hs 20_1, 20_2...20_N and functions as a router for directing IP traffic between the mobile T/Hs 20_1, 20_2...20_N via the Internet 14. The IP traffic in the downstream direction (i.e., from the BS 18 to the T/H) is broadcasted by the BS 18, while in the upstream direction (i.e., from the T/H to the BS 18) the IP traffic is transmitted through a statistically shared upstream radio channel. Each of the mobile T/Hs 20_1, 20_2...20_N (mobile T/H 20) can communicate with at least two BSs, simultaneously.

Each cell 12 has its own IP address, e.g., NETID, to identify the cell, and a plurality of virtual access ports to which different mobile T/Hs 20_1, 20_2...20_N are attached to communicate with each other via the Internet 14 under control of the BS 18. To identify these access ports, each access port has a host IP address, e.g., HOSTID.

Each mobile T/H 20 has a permanent domain name for identifying the T/H. The domain name is stored in a non-volatile memory of the respective T/H. Further, each mobile T/H 20 has a domain name server (DNS) for registering therein the domain name of the mobile T/H under a new class of domain names, e.g., Mobile Internet Class (MIC). The DNS of each mobile T/H 20 also stores and updates the IP address of the mobile T/H 20, which represents the current address of the mobile T/H 20. As the mobile T/H 20 roams across the network (e.g., the Internet 14) by, e.g., attaching itself to a new BS, the mobile T/H 20 acquires a new IP address. The DNS of the mobile T/H 20 updates the IP address of the T/H 20 with the newly obtained IP address. If the mobile T/H 20 disconnects itself completely from the network, the DNS does not store any IP address for the mobile T/H 20.

The new IP addresses are assigned by an m-DHCP (Dynamic Host Control Protocol) server as the T/Hs 20_1, 20_2...20_N roam through the network, constantly changing their IP addresses. Each BS 18 can incorporate therein an m-DHCP server or its functions. If the BS 18 incorporates the m-DHCP server, a number of IP addresses allocated to each BS 18 is greater than the maximum number of mobile T/Hs 20_1, 20_2...20_N that are presently attached to the corresponding cell. Whenever an IP address that is no longer in use is returned to the collection of IP addresses in the m-DHCP server, the returned IP address is temporarily unavailable for a predetermined time period

to avoid interferences between previous and current connections. The predetermined time period is typically greater than the maximum time an old segment can remain alive in the Internet 14, and this provides sufficient time to update the corresponding DNS.

The assignment of new IP addresses to the mobile T/Hs 20_1, 20_2...20_N is initiated by a request signal sent from the mobile T/H 20. The mobile T/H 20, seeking a new IP address, generates an m-DHCP request signal to the m-DHCP server. The m-DHCP request signal from the mobile T/H 20 contains the T/H 20's domain name for identifying the mobile T/H 20 and the unique hardware address (e.g., MAC address) of the mobile T/H 20. In response to the m-DHCP request signal, the m-DHCP server informs the mobile T/H 20 of the following: the new IP address that has been leased to the mobile T/H 20, the duration of the lease, the IP address of the BS, and the IP address of the DNS that provides name resolution services for the cell (sub-network) having the BS. The mobile T/H 20 has to renew the lease periodically while it is attached to a particular virtual access port of the cell to avoid the expiration of the lease. The lease can be terminated at any time by the mobile T/H 20. If the lease were to expire, the mobile T/H 20 loses its IP address. The m-DHCP server informs the corresponding DNS of the lease cancellation, lease expiration, or the allocation of an IP address to the mobile T/H 20.

The operation of an m-TCP connection according to the present invention is described below. Here, the Client is a stationary or mobile T/H that wishes to initiate an m-TCP connection with its m-TCP peer, and the Server (the m-TCP peer) is a stationary or mobile T/H that wishes to accept the m-TCP connection request from the client.

The operation of an m-TCP connection can be classified into three phases. The first phase is a connection phase where an m-TCP connection between two communication entities, e.g., a mobile T/H and a host (e.g., stationary or mobile T/H) is made; the second phase is an exchange phase where data segments are exchanged between the connected communicating m-TCP entities; and the third phase is a closing phase where the established m-TCP connection is terminated.

In the connection phase, a mobile T/H 20 (Server), that is willing to accept an m-TCP connection, executes a passive open function in its application program to indicate

to its m-TCP layer that it is willing to accept an m-TCP connection on a specified m-TCP port number. A host (Client), that wishes to establish an m-TCP connection with its m-TCP peer, then obtains the current IP address of the mobile T/H 20 from the DNS of the mobile T/H 20, and executes an active open function to specify the destination endpoint of the connection (i.e., the IP address of the mobile T/H 20 and its m-TCP port number). The active and passive open functions are known in the art. The m-TCP program on the host side creates and transmits a connection request signal to the mobile T/H 20 using the obtained current IP address of the mobile T/H 20.

If the IP address of the mobile T/H 20 has been changed during this process, a soft switch-over mechanism ensures that the host's connection request signal reaches the mobile T/H 20. The soft switch-over mechanism allows the mobile T/H 20 to retain the old IP address after it has acquired the new IP address. Hence, the mobile T/H 20 is able to receive the datagrams that have been delayed in the network on the old IP address. After a set time period, the old IP address is relinquished.

If the old IP address of the mobile T/H 20 has been relinquished on the mobile T/H 20 side before the connection request has reached the mobile T/H 20, then the current attempt by the host to connect to the mobile T/H 20 fails. In this case, the connection process must be repeated to establish the m-TCP connection. To do so, the TCP program on the host side will access the DNS of the mobile T/H 20 again to obtain a new IP address of the mobile T/H 20.

On the other hand, the mobile T/H 20 (now Client) may wish to establish an m-TCP connection with the host (now Server). In this case, the application program in the host that wishes to accept an m-TCP connection, executes a standard passive open function, indicating that it is willing to accept an m-TCP connection on a specified m-TCP port number. The application program in the mobile T/H 20 then executes an active open function and specifies the destination endpoint of the connection (i.e., the IP address of the host and its m-TCP port number) as discussed above to establish the m-TCP connection.

To establish the m-TCP connection, the m-TCP utilizes a three-way handshake known in the conventional TCP. In addition to exchanging the standard TCP parameters,

two additional parameters during the setup of the m-TCP connection will be exchanged according to the present invention. The two parameters, which must be globally unique, are a local connection identification (local_conId) and a remote connection identification (remote_conId). These parameters form a connection identification (conID) for uniquely identifying the m-TCP connection (i.e., conID = local_conId, remote_conId), and are included in every data segment communicated between the m-TCP entities even after the IP addresses change. By including the conID in every data segment with the new IP addresses, the m-TCP entity receiving the conID with the new IP address determines the m-TCP connection based on the conID, and delivers the datagrams appropriately, e.g., to a socket, a service access point, or the like.

The two parameters in the conID are chosen during the first phase of the m-TCP connection, and uniquely identify the m-TCP connection. Each side of the m-TCP connection selects a local_conId for identifying itself to the other side, so that the local_conId of one side becomes the remote_conId of the other side. These parameters can be numbers randomly chosen from each side, such that the conID can be a combination of these number, e.g., 27009876.

The conID is included in the m-TCP header of each m-TCP data segment. Fig. 3 shows an example of an m-TCP header structure according to the present invention. As shown therein, the m-TCP header 30 includes a source port ID field, a destination port ID field, an initial or incremented sequence number stored in a sequence number field 31, an acknowledgement number field, a reserved area 34, a TCP checksum field, and an information data field 38 according to a known TCP header. These fields are processed according to a conventional TCP three-way handshake. In addition, the m-TCP header 30 according to the present invention includes a global ID field 32 divided into a local connection field 32a and a remote connection field 32b. The global ID field 32 is located in a field 36 for options. Each of the fields 32a and 32b may be predeterminedly long, e.g., two octets. The local connection field 32a stores the local_conId therein, and the remote connection field 32b stores the remote_conId therein.

More specifically in the three-way handshaking process, if a first entity (e.g., first mobile T/H 20_1) wishes to establish an m-TCP connection with a second entity (e.g.,

second mobile T/H 20_2), the first entity creates a first segment signal for requesting a setup of an m-TCP connection. The first segment signal includes a SYN bit (SYN = 1) set in a code field 36 of the m-TCP header 30, and a local_conId value set in the local connection field 32a of the m-TCP header 30. At this time, the remote connection field 32b is left blank. Upon receipt of the first segment signal, the second entity generates a second segment signal for acknowledging the receipt of the first segment signal. The second segment signal includes SYN and ACK bits (SYN=1, ACK=1) set in the code field 36 of its own m-TCP header, and the selected local_conId value set in its local connection field. In the remote connection field of the m-TCP header of the second entity, the content of the local connection field 32a of the received first segment signal is copied and stored. Upon receipt of the second segment signal, the first entity generates a third segment for acknowledging the receipt of the second segment signal, and informs the second entity that the m-TCP connection has been successfully established.

The operation of the m-TCP connection in the second phase, once the m-TCP connection has been established, is similar to the operation of a conventional TCP in the second phase, except for certain modifications as discussed below.

In the m-TCP of the present invention, the conventional TCP is modified to store the constantly changing end points (IP address and TCP port number) of the m-TCP connection since the mobile T/Hs 20 change their connection end points constantly as they roam across the network. The m-TCP uses conIDs to route the incoming segments appropriately, e.g., to a socket, a service access point, or the like, based on the conIDs. For the outgoing segments, the m-TCP transmits the data segments based on the current IP addresses. Furthermore, the m-TCP saves the conID, the initial end point information for both ends, and the current endpoint information for both ends. This information can be available to other application programs.

The remote endpoint information (i.e., remote IP address and port number) is obtained from the arriving data segment since each arriving data segment contains the conID and the present source IP address, where the source IP address is part of the endpoint information of the entity on the other side of the m-TCP connection. If the data segments are out of sequence, the sequence number that is also contained in the field 31

of the m-TCP header is used to determine which data segment is the most recent one and provides the most recent source IP address.

Whenever a mobile T/H obtains a new IP address and there are no outgoing data segments to be sent with the new IP address, the m-TCP sends a dummy segment DS to its m-TCP peer to inform its peer of the new IP address. Furthermore, during the life of an m-TCP connection, the m-TCP continuously sends DSs (dummy segments with no information data) to its m-TCP peer at regular time intervals.

Receipt of each DS is acknowledged by the receiving m-TCP with a dummy segment acknowledgment segment (DS ACK). The m-TCP marks the data segment being transmitted as the DS or the DS ACK using one of the reserved bits (e.g., UPD bit in the header 30) existing in the m-TCP header. For example, the UPD bit can be set to one if the current data segment is a DS, and both the UPD and ACK bits can be set to one if the current data segment is a DS ACK. If the transmitted DS is not acknowledged by the receiving m-TCP, it is retransmitted until the acknowledgment is received.

Each DS includes a unique sequence number for identifying the particular DS. This sequence number is stored in the sequence number field 31 of the m-TCP header, and is independently incremented. The sequence number incrementation process of the DSs is different from the sequence number incrementation process for segments with information data, because DSs do not carry information data and the incrementation for the segments with information data is performed based on the size of the information data. The sequence number incrementation for the DSs begins with an initial sequence number (e.g., 1) and increases the sequence number by a preset value (e.g., 1). The sender of a new DS increments the previous sequence number and includes the newly incremented sequence number in the new DS, so that each DS includes a new sequence number. The receiver of the DSs checks the sequence numbers and processes the most current sequence numbered DS while ignoring the old sequence numbered DSs in case of network delays, etc. The receiver of the DS sends a DS ACK to the sender, which includes the received sequence number.

The DS and DS ACK are not subjected to buffering or flow control. The DS and DS ACK are continuously exchanged at a regular time interval until the m-TCP

connection is completely closed. That is, they are exchanged in both directions until the m-TCP connection is closed in both directions.

After the datagrams have been exchanged between the connected m-TCP entities, the connection may be terminated. The last termination phase of the m-TCP is performed in the same way as the termination phase of conventional TCP connection procedures.

Accordingly, an m-TCP and a method of establishing and maintaining an m-TCP connection according to the present invention allow mobile T/Hs to communicate with each other via the Internet using minimum variables.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. A communication method of a first communication entity for establishing a mobile TCP (transmission control protocol) connection between the first communication entity and a second communication entity, comprising the steps of:

transmitting a first segment signal to the second communication entity, the first segment signal including a connection identification of the first communication entity;

receiving a second segment signal from the second communication entity in response to the first segment signal, the second segment signal including a connection identification of the second communication entity and the connection identification of the first communication entity, the connection identifications of the first and second communication entities forming a mobile TCP connection identification for the first and second communication entities; and

transmitting a third segment signal to the second communication entity in response to the second segment signal.

2. The communication method of claim 1, wherein in the receiving step, the second segment signal further includes acknowledgement data for acknowledging receipt of the first segment signal by the second communication entity.

3. The communication method of claim 1, wherein in the step of transmitting a third segment signal, the third segment signal includes acknowledgement data for acknowledging receipt of the second segment signal by the first communication entity.

4. The communication method of claim 1, wherein in the step of transmitting a first segment signal, at least one of the first and second communication entities is a mobile terminal having a changing IP address.

5. A communication method of a second communication entity for establishing a mobile TCP (transmission control protocol) connection between a first communication entity and the second communication entity, comprising the steps of:

receiving a first segment signal from the first communication entity, the first segment signal including a connection identification of the first communication entity; and

transmitting a second segment signal to the first communication entity in response to the first segment signal, the second segment signal including a connection identification of the second communication entity and the connection identification of the first communication entity, the connection identifications of the first and second communication entities forming a mobile TCP connection identification for the first and second communication entities.

6. The communication method of claim 5, wherein in the transmitting step, the second segment signal further includes acknowledgement data for acknowledging receipt of the first segment signal by the second communication entity.

7. The communication method of claim 5, further comprising the step of:

receiving a third segment signal from the first communication entity for acknowledging receipt of the second segment signal by the first communication entity.

8. The communication method of claim 5, wherein in the receiving and transmitting steps, at least one of the first and second communication entities is a mobile terminal having a changing IP address.

9. A computer program embodied on a computer-readable medium of a first communication entity for establishing a mobile-TCP (transmission control protocol) connection between the first communication entity and a second communication entity, comprising:

a first source code segment for generating a first segment signal and transmitting the generated first segment signal to the second communication entity, the first segment signal including a connection identification of the first communication entity; and

a second source code segment for generating a third segment signal and transmitting the generated third segment signal to the second communication entity in response to a second segment signal from the second communication entity, the second segment signal including a connection identification of the second communication entity and the connection identification of the first communication entity, the connection identifications of the first and second communication entities forming a mobile TCP connection identification for the first and second communication entities.

10. The computer program of claim 9, wherein the third segment signal includes acknowledgment data for acknowledging receipt of the second segment signal by the first communication entity.

11. A computer program embodied on a computer-readable medium of a second communication entity for establishing a mobile TCP (transmission control protocol) connection between a first communication entity and the second communication entity, comprising:

a first source code segment for receiving a first segment signal from the first communication entity, the first segment signal including a connection identification of the first communication entity; and

a second source code segment for generating a second segment signal to the first communication entity in response to the received first segment signal, the second segment signal including a connection identification of the second communication entity and the connection identification of the first communication entity, the connection identifications of the first and second communication entities forming a mobile TCP connection identification for the first and second communication entities.

12. The computer program of claim 11, further comprising:

a third source code segment for receiving and verifying a third segment signal generated from the first communication entity in response to the second segment signal.

13. A computer data signal of a first communication entity for establishing a mobile TCP connection between the first communication entity and a second communication entities, comprising:

a first signal segment including a connection identification of the first communication entity and transmitted to the second communication entity; and

a third signal segment for responding to a second signal segment from the second communication entity, the second signal segment including a connection identification of the second communication entity and the connection identification of the first communication entity, and transmitted from the second to the first communication entity in response to the first signal segment, the connection identifications of the first and second communication entities forming a mobile TCP connection identification for the first and second communication entities.

14. The computer data signal of claim 13, wherein the third signal segment includes acknowledgement data for acknowledging receipt of the second signal segment.

15. The computer data signal of claim 13, wherein said computer data signal is embodied in a carrier wave.

16. A computer data signal of a second communication entity for establishing a mobile TCP connection between a first communication entity and the second communication entities, comprising:

a second signal segment for responding to a first signal segment generated from the first communication entity, the first signal segment including a connection identification of the first communication entity, the second signal segment including a connection identification of the second communication entity and the connection identification of the first communication entity, and transmitted from the second to the first communication entity, the connection identifications of the first and second communication entities forming a mobile TCP connection identification for the first and second communication entities.

17. The computer data signal of claim 16, wherein the second signal segment includes acknowledgement data for acknowledging receipt of the first signal segment by the second communication entity.

18. The computer data signal of claim 16, wherein said computer data signal is embodied in a carrier wave.

19. A computer data signal for communication in a mobile TCP (transmission control protocol) connection established between first and second communication entities, comprising:

a local connection field containing a connection ID (identification) of the first communication entity; and

a remote connection field containing a connection ID of the second communication entity, wherein the local and remote connection fields provide a globally unique mobile TCP connection ID.

20. The computer data signal of claim 19, further comprising:

a data field for carrying data messages.

21. The computer data signal of claim 19, further comprising:

a reserved area containing information indicating whether or not the data segment is a dummy segment carrying no data messages.

22. The computer data signal of claim 21, wherein in the reserved area, the information is contained in a UPD bit.

23. The computer data signal of claim 19, further comprising:

a sequence number field containing a sequence number for identifying the data segment.

24. The computer data signal of claim 19, further comprising:

a field containing current IP (internet protocol) addresses of the first and second communication entities.

25. A mobile TCP (transmission control protocol) embodied on a computer-readable medium of a first communication entity, comprising:

a first source code segment for receiving a data segment having a source IP (internet protocol) address and a mobile TCP connection ID (identification) from a second communication entity, the source IP address representing a current IP address of the second communication entity, the mobile TCP connection ID representing a connection identification of a mobile TCP connection established between the first and second communication entities; and

a second source code segment for updating a remote IP address variable with the received source IP address based on the mobile TCP connection ID.

26. The mobile TCP of claim 25, further comprising:

a third source code segment for processing the data segment based on the mobile TCP connection ID.

27. The mobile TCP of claim 25, wherein the second source code segment determines which data segment is the most recent one based on a sequence number included in each data segment.

28. The mobile TCP of claim 25, wherein the mobile TCP connection ID is two octets long.

29. The mobile TCP of claim 25, wherein the mobile TCP connection ID stays the same as long as the mobile TCP connection has been established between the first and second communication entities.

30. The mobile TCP of claim 25, wherein at least one of the first and second communication entities is a mobile terminal having a changing IP address as the mobile terminal roams a network.

31. The mobile TCP of claim 25, wherein the data segment includes data carrying a user's message.

32. The mobile TCP of claim 25, wherein the data segment is a dummy segment carry no user's message.

33. The mobile TCP of claim 25, wherein if the first communication entity obtains a new IP address of the first communication entity and there is no data message to be sent, the second source code segment generates a dummy segment to the second communication entity, the dummy segment containing the new IP address and the mobile TCP connection ID without any data messages.

34. The mobile TCP of claim 33, wherein the second source code segment generates the dummy segment at regular time intervals.

35. The mobile TCP of claim 33, wherein the dummy segment includes a first predetermined bit for indicating that the segment is a dummy segment.

36. The mobile TCP of claim 35, wherein the first predetermined bit is a UPD bit set to one.

37. The mobile TCP of claim 33, wherein the second code segment generates a dummy segment acknowledgment segment for acknowledging receipt of a dummy segment if sent from the second communication entity.

38. The mobile TCP of claim 37, wherein the dummy segment acknowledgment segment includes a UPD bit and an ACK bit both set to one.

39. A method of communicating in a mobile TCP (transmission control protocol) connection between first and second communication entities, comprising the steps of:

transmitting, from the first to the second communication entity, a segment having a source IP (internet protocol) address and a mobile TCP connection ID (identification), the source IP address representing a current IP address of the first communication entity, the mobile TCP connection ID representing a connection identification of the mobile TCP connection made between the first and second communication entities;

receiving the transmitted segment in the second communication entity;

updating a remote IP address variable of the second communication entity with the source IP address using the mobile TCP connection ID of the transmitted segment; and

processing the transmitted segment based on the mobile TCP connection ID.

40. The method of claim 39, further comprising the step of:

determining which segment is the most recent one based on a sequence number included in the transmitted segment.

41. The method of claim 39, wherein in said transmitting step, the mobile TCP connection ID is two octets long.

42. The method of claim 39, wherein the mobile TCP connection ID stays the same as long as the mobile TCP connection has been made between the first and second communication entities.

43. The method of claim 39, wherein at least one of the first and second communication entities is a mobile terminal having a changing IP address as the mobile terminal roams through a network.

44. The method of claim 39, wherein in said transmitting step, the segment includes data carrying a user's message.

45. The method of claim 39, further comprising the step of:

whenever the first communication entity obtains a new IP address, generating a dummy segment by the first communication entity, the dummy segment containing the new IP address and the mobile TCP connection ID without data messages.

46. The method of claim 45, wherein in the generating step, the dummy segment includes a first predetermined bit for indicating that the segment is a dummy segment.

47. The method of claim 46, wherein the first predetermined bit is a UPD bit set to one.

48. The method of claim 45, further comprising the step of:

generating an acknowledgment segment for acknowledging receipt of the dummy segment by the second communication entity.

49. The method of claim 48, wherein the acknowledgment segment includes a UPD bit and an ACK bit both set to one.

FIG. 1

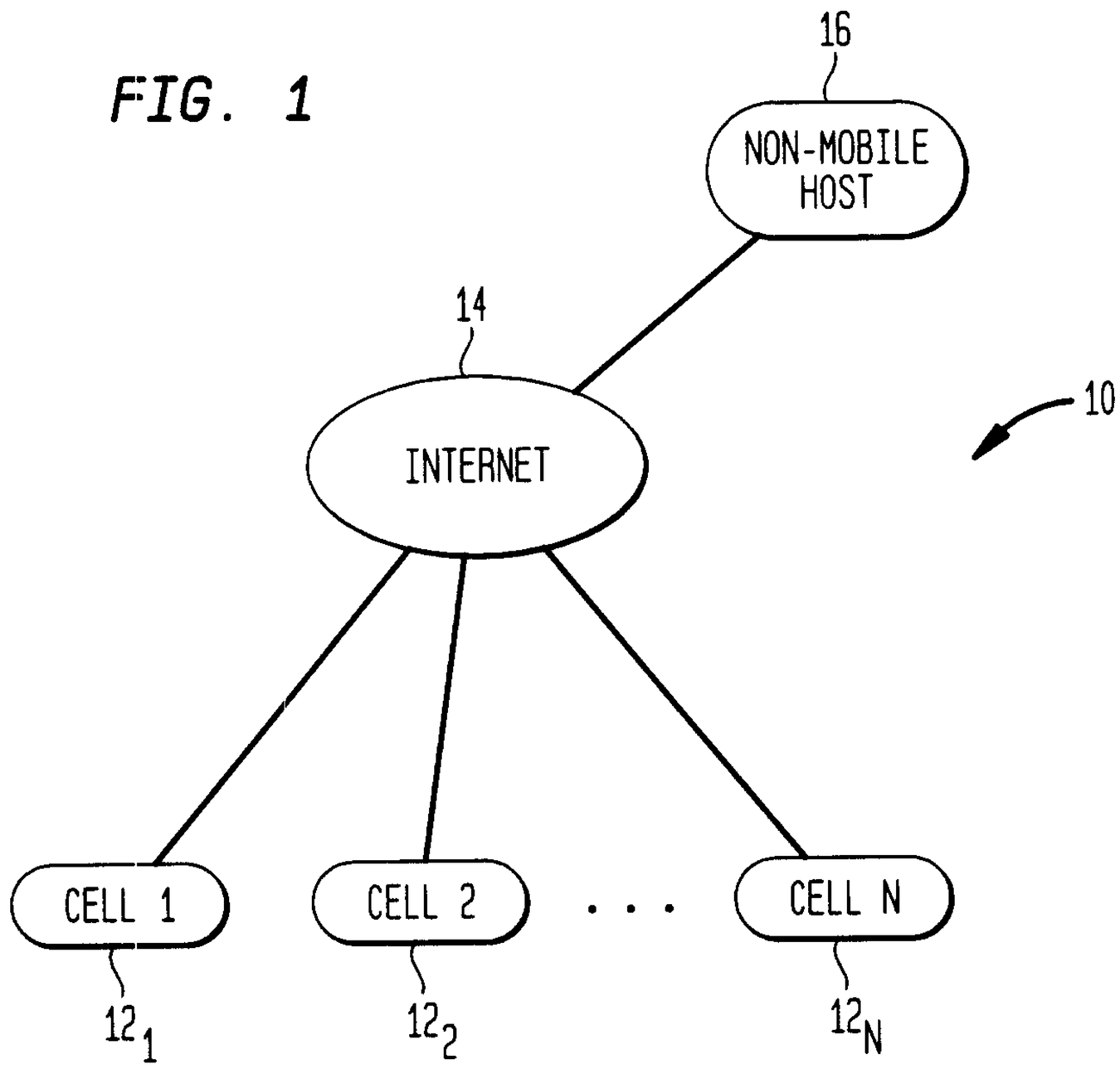

16
NON-MOBILE HOST
14
INTERNET
10
CELL 1
CELL 2
. . .
CELL N
12 1
12 2
12 N

FIG. 2

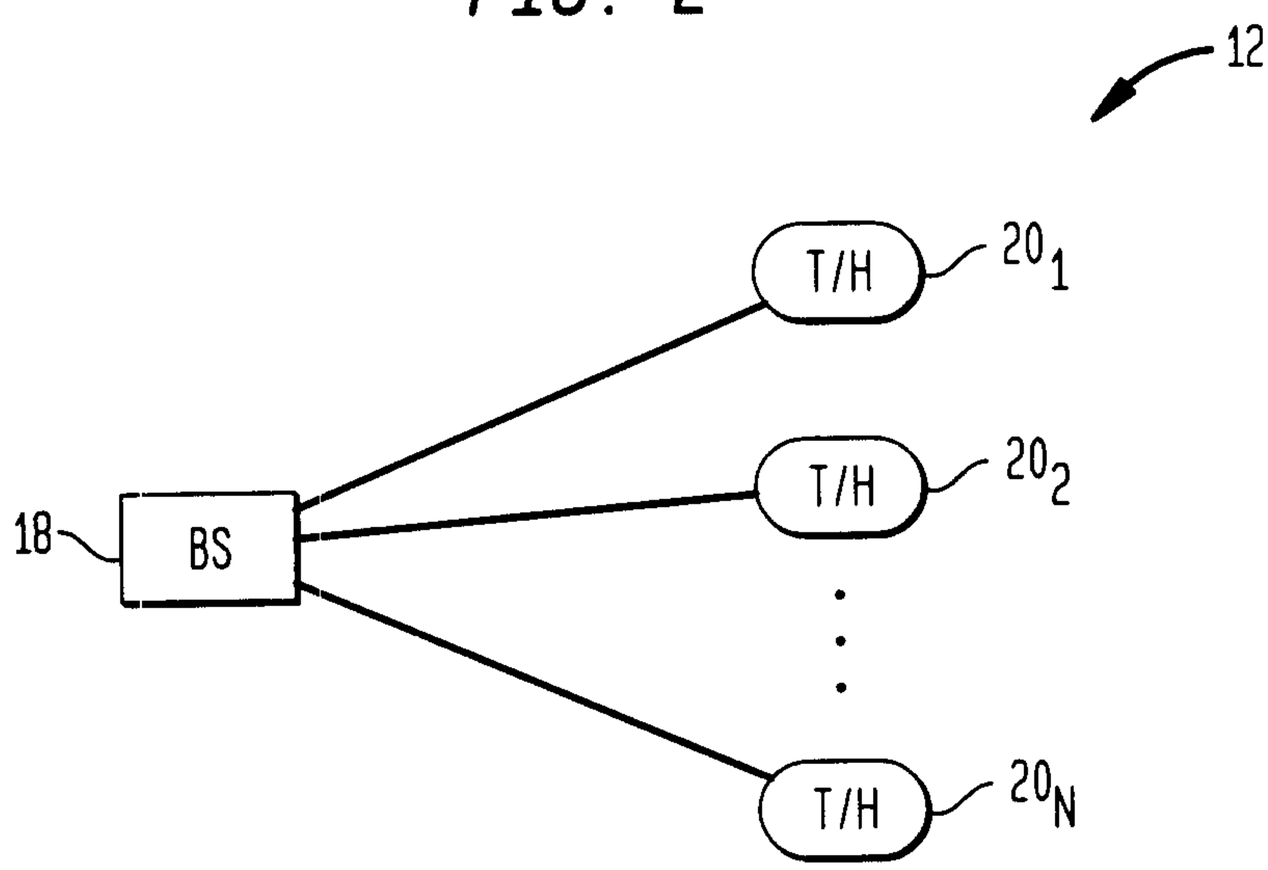
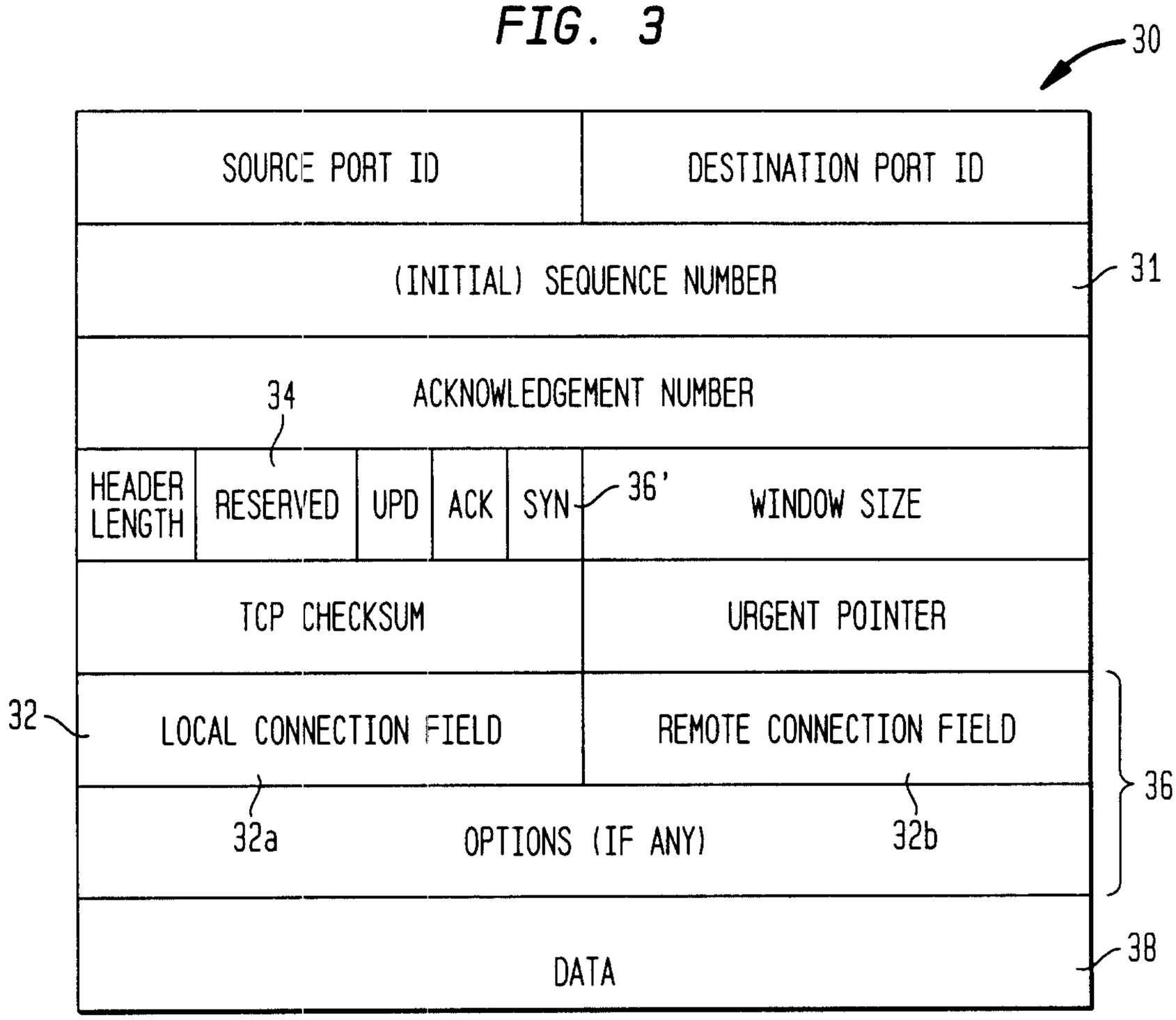

12
T/H
20 1
T/H
20 2
18
BS
T/H
20 N

FIG. 3


30
SOURCE PORT ID
DESTINATION PORT ID
(INITIAL) SEQUENCE NUMBER
31
34
ACKNOWLEDGEMENT NUMBER
HEADER LENGTH
RESERVED
UPD
ACK
SYN
36'
WINDOW SIZE
TCP CHECKSUM
URGENT POINTER
32
LOCAL CONNECTION FIELD
REMOTE CONNECTION FIELD
36
32a
OPTIONS (IF ANY)
32b
DATA
38