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UK CL (Edition S) **H4L LRPMG LRPML LRPMS LRPMW**
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(54) Abstract Title
Preparing for handover in a communication system

(57) Apparatus for, and a method of operating, a communication system, for example a UMTS or GPRS cellular communication system, are described. A communication link is provided between two terminals, one of which is a mobile terminal. The communication system employs a congestion reduction protocol, such as Transmission Control protocol (TCP), which provides a congestion reduction mechanism by modifying transmission rates. When handover is to occur such that a first radio link will be replaced by a second radio link, the bit-rates of each radio link are determined compared, and a current value of a transmission characteristic which influences the congestion reduction protocol is adjusted over time to prepare for handover. The transmission characteristic may for example be bit-rate or TCP acknowledgement delay. False invoking of congestion procedure by the congestion reduction protocol is thereby alleviated.

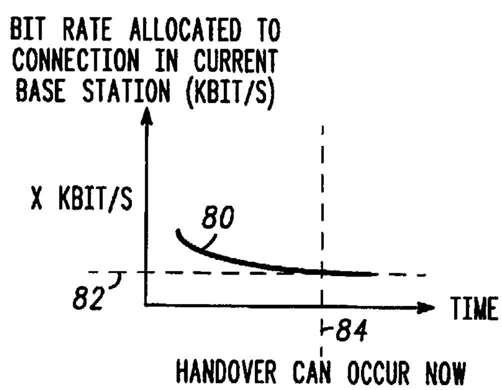

FIG. 4

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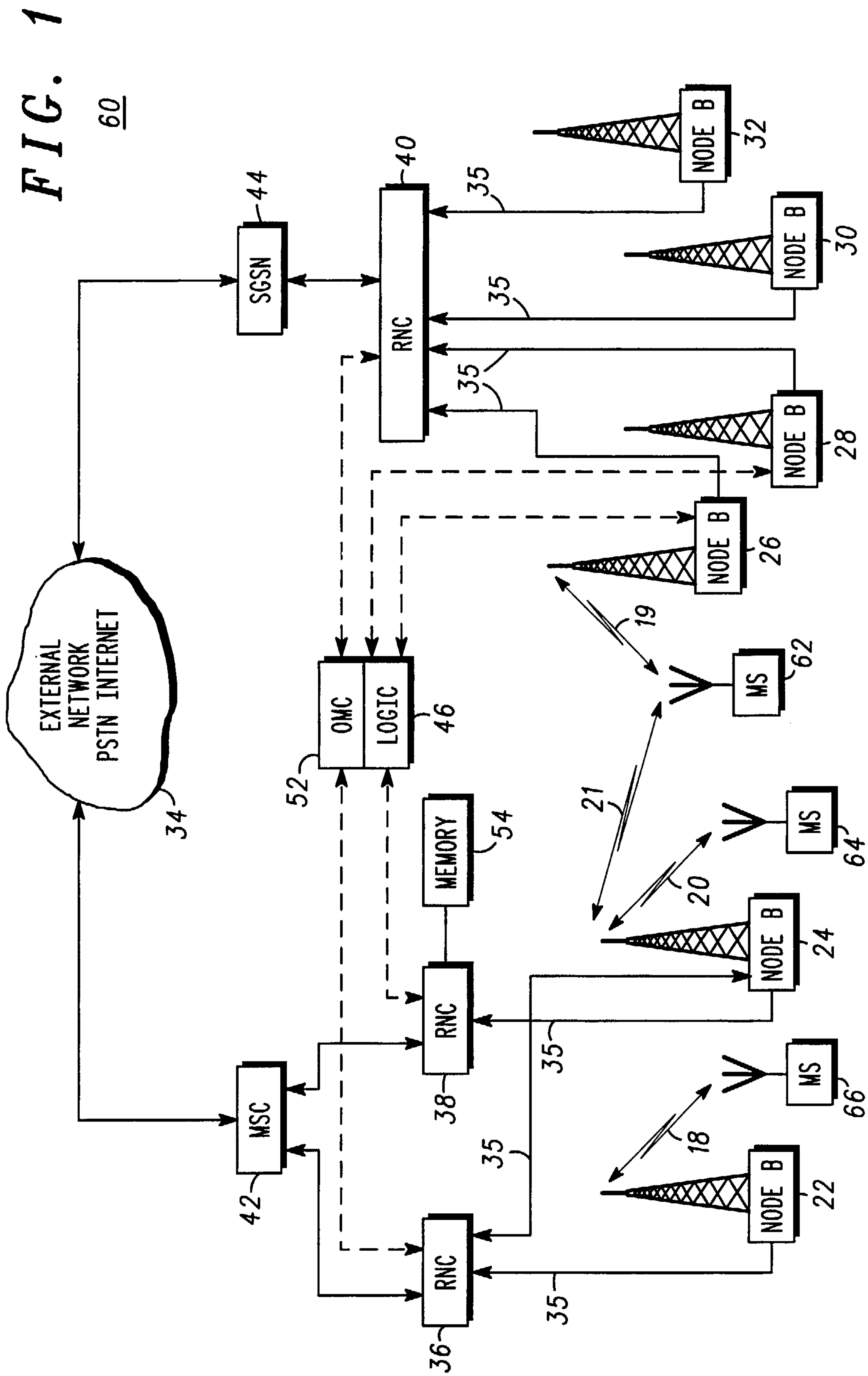
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FIG. 1

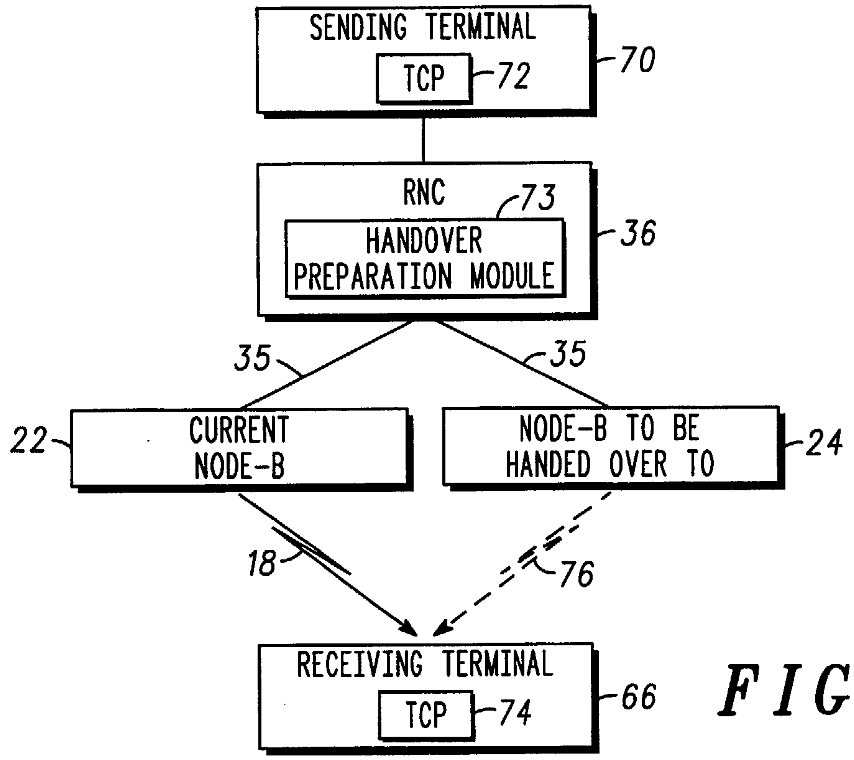

FIG. 2

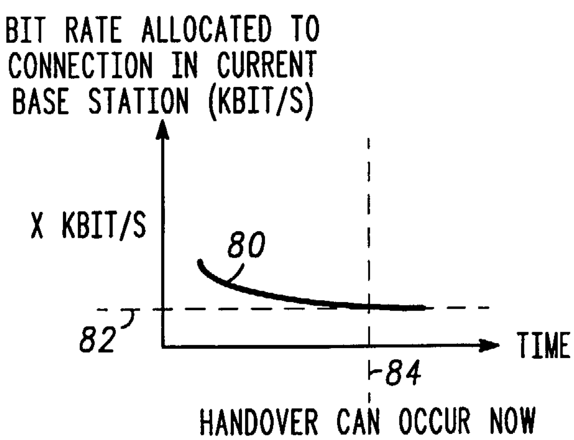

FIG. 4

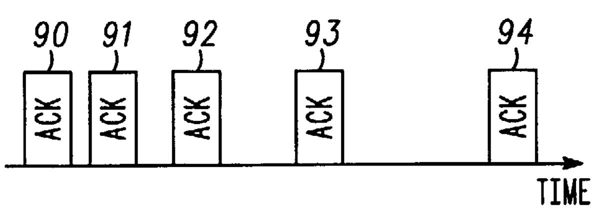

FIG. 5

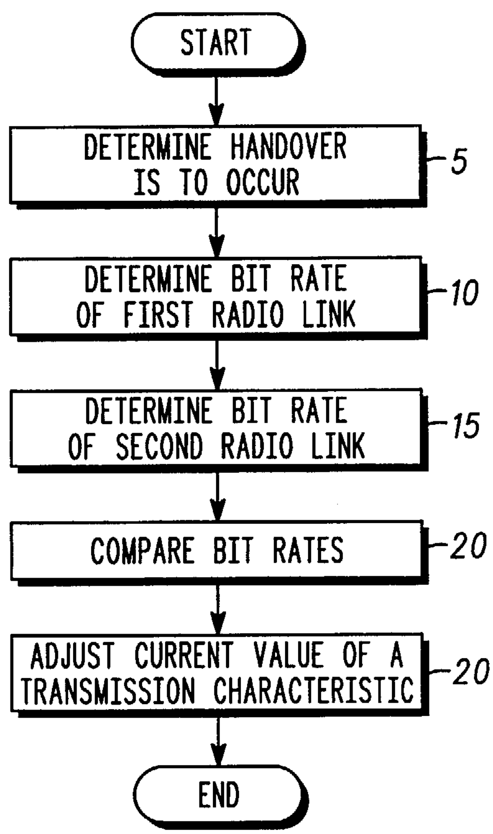

FIG. 3

PREPARING FOR HANDOVER IN A COMMUNICATION SYSTEM

Field of the Invention

This invention relates to communication systems providing communication links which comprise at least one radio link and which employ a congestion reduction protocol, for example the Transmission Control Protocol (TCP). The invention is applicable to, but not limited to the Universal Mobile Telecommunications System.

Background of the Invention

The TCP (Transmission Control Protocol), as specified in Internet protocol standard RFC 793, is a protocol which runs on top of IP (Internet protocol) and may be used in each of the two terminals involved in a communication. TCP ensures that data packets are delivered more correctly across an IP network, such as the internet.

The TCP protocol includes mechanisms for ensuring that in IP networks, such as the internet, congestion does not occur, or is at least reduced, when a new packet call is commenced, by providing a 'slow start' mechanism. Furthermore, TCP modifies transmission rate when congestion does occur, by providing a 'congestion avoidance' (or at least congestion reduction) mechanism.

The TCP protocol is only operated on the end terminals and was originally designed on the basis that the connection would be provided over fixed wire-line (not radio) links.

Since TCP and other congestion reduction protocols were introduced, cellular communication systems and networks have been developed which perform packet switching and other inter-network communication, including internet and other information network accessing. Such cellular communication systems include inter-alia ones compliant with UMTS, and/or the General Packet Radio System (GPRS). Such systems divide service area into cells, and it can be necessary to perform handover between cells, i.e. replacing a radio link in one cell with a radio link in another cell.

When congestion avoidance is instigated the TCP in a sending terminal reduces its congestion window size (or put another way: reduces the rate at which it is transmitting). This reduction in bit rate can be very substantial. The subsequent process of increasing the bit rate again to the optimal rate can take a long time.

TCP, which is well understood by the skilled person, allocates a re-transmission time-out window value to a sending terminal according to conditions such as available transmission bit-rate. The communication system sends back to the terminal acknowledgements (ACK's) of data successfully transmitted. Under TCP, the sending terminal assumes congestion has occurred when an acknowledgement does not arrive within the re-transmission time-out window. In response to an assumed congestion situation, the sending terminal for example reduces its transmission rate.

Unnecessary invoking of congestion avoidance, for example when packet loss has occurred due to an error or due to handover as opposed to congestion, can sometimes occur therefore when TCP is employed in a communication system incorporating handover between two radio links.

Indeed, when one of the links (in an end to end communication) is over a mobile radio channel then there are a number of features of the radio channel or link which could cause problems for the TCP. For example, packet delays or other problems over the air interface may result in delayed ACK's, instigating unnecessary congestion avoidance. Handover (synonymous with hand-off) results in a transmission discontinuity and potentially a difference between the bit rate supported in the old cell and the new cell.

When handover occurs, packet loss may result and congestion avoidance may be instigated even though sometimes there is not actually a congestion problem in the new cell. On other occasions there may be limited bandwidth in the new cell and some mechanism should be provided for dealing with the potential change in the congestion situation.

If the hand-off is between a cell of a 2nd generation (2G) cellular communication system such as the Global System for Mobile communication (GSM) operating at a low bit rate and a cell of a 3rd generation (3G) cell-based communication system such as UMTS operating at a high bit rate or vice-versa then there may be a very substantial difference in the data rates supportable before and after hand-off (i.e. a difference in the congestion situation). Note, however, that the problem can still occur between cells of the same generation, for example 3G to 3G hand-off.

The most pertinent prior art known to the inventors relating to operating TCP over a communication channel where one of the links is wireless and subject to handover includes:

[1] H. Balakrishnan et al, 'A comparison of mechanisms for improving TCP performance over wireless links', IEEE/ACM Trans on networking, Vol 5, No. 6, Dec 97

[2] A. Chan et al, 'Impacts of handoff on TCP performance in mobile wireless computing', IEEE ICPWC '97 conference

[3] L. Taylor et al, 'The challenges of seamless handover in future mobile multimedia networks', IEEE personal communication , April 1999

The prior art arrangements contain conventional approaches to dealing with TCP operation when hand-off occurs. In general, the emphasis in the prior art arrangements is on how to deal with the potential packet loss that may occur on handover. In [1] it is stated that typical solutions fall into one of three categories:

a) End to End proposals: These attempt to make the TCP sender handle losses through two techniques:

i) Use of selective acknowledgements, to allow the sender to recover from multiple packet losses in a window without resorting to a coarse time-out.

ii) Attempt to make the sender distinguish between congestion and other reasons for packet loss by an explicit loss notification mechanism (sent by a base station or base site controller to the sending terminal to inform it if a handover is occurring).

b) Split-connection proposals: Here the TCP protocol is terminated at the base station, so that the wireless links are completely hidden from TCP. Another, possibly wireless specific transport protocol may be used between the base station and the terminal.

c) Link layer proposals: Here a new link layer is introduced to handle re-transmissions and error correction, this link layer will typically be run between the base station and the terminal. TCP will still be terminated in the terminals.

Summary of Invention

However, the present inventors have realised that the prior art approaches fail to take into account how differences between the bit rate (i.e. transmission rate, bandwidth) available in the current cell and the hand-off cell may affect TCP performance. Specifically, when connection is handed over from a cell in which high rates are supportable to one in which they are not, there is a danger that there will be a severe reduction in bit rate as the congestion avoidance mechanism kicks in.

The present inventors have therefore realised that it would be desirable to prepare TCP for a handover (when the data rates available in the current cell and the hand-off cell are different) so as to avoid an unfavourable response by the congestion avoidance algorithm.

According to a first aspect, the present invention provides a method of operating a communication system, as claimed in claim 1.

According to a second aspect, the present invention provides apparatus for a communication system, as claimed in claim 15.

According to a third aspect, the present invention provides a communication unit comprising the apparatus of the second aspect, as claimed in claim 27.

According to a fourth aspect, the present invention provides a communication system comprising the apparatus of the second aspect, as claimed in claim 28.

According to a fifth aspect, the present invention provides a method of preparing for handover from a first radio link to a second radio link in a cellular communication network, as claimed in claim 29.

According to a sixth aspect, the present invention provides a communication unit operable to perform the steps of the methods of the first and third aspects, as claimed in claim 31.

In a seventh aspect the present invention provides a storage medium, as claimed in claim 32.

Further aspects are as claimed in the dependent claims.

The present invention alleviates the problems of prior art arrangements by adjusting operation in a current radio link (e.g. cell), prior to handover, so that a feature of operation related to the congestion reduction protocol (e.g. TCP) is gradually adjusted to be more suitable for what the conditions will be in the new radio link (e.g. cell) after handover.

One feature of operation that can be adjusted is bit-rate. Another is the acknowledgement (ACK), e.g. by progressively delaying the TCP ACK's being sent from the wireless system infrastructure to the sending entity.

As a result of, for example, gradually reducing the data rate available in the current cell prior to handing off to a cell in which less bandwidth is available, it is possible for the sending TCP entity to increase its re-transmission time-out window and thereby avoid the invocation of the severe back-off of the congestion avoidance mechanism (and resulting decrease in throughput) when handover occurs.

Brief Description of the Drawings

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 shows a UMTS cellular communication system;

FIG. 2 illustrates certain components in a communication link provided using the cellular communication system of FIG. 1;

FIG. 3 is a flowchart illustrating the process steps carried out by a handover preparation module in order to prepare for handover;

FIG. 4 shows a qualitative plot of bit-rate as it is adjusted prior to handover in one embodiment of the present invention; and

FIG. 5 shows qualitatively an increase in the delay between TCP acknowledgements being forwarded in another embodiment of the present invention.

Description of Preferred Embodiments

In the first embodiment, the invention is applied to a UMTS cellular communication system using TCP, but it is to be appreciated that the invention can be applied to any system involving radio link handover and a congestion reduction protocol.

FIG. 1 shows a UMTS cellular communication system 60.

A plurality of subscriber terminals (also known as mobile stations and hereinafter referred to as MS's) 62-66 communicate over radio links 18-21 with a plurality of base stations, referred to under UMTS terminology as Node-B's, 22-32. For clarity purposes, only a limited number of MS's 62-66 and Node-B's 22-32 are shown.

The Node-B's 22-32 are connected to external networks, for example, the public-switched telephone network (PSTN) or the Internet, 34 through Radio Network Controller stations (RNC) (in UMTS terminology) 36-40 and plural mobile switching centres (MSC's), such as MSC 42 (the others are, for clarity, not shown) and Serving GPRS Support Nodes (SGSN) 44.

Each Node-B 22-32 contains one or more transceiver units and communicates with the rest of the cell-based system infrastructure via the I_{ub} interface 35 as defined in the UMTS specification.

Each RNC 36-40 may control one or more Node-B's 22-32. Each MSC 42 provides a gateway to the external network 34, whilst the SGSN 44 links to external packet networks.

The Operations and Management Centre (OMC) 46 is operably connected to RNC's 36-40 and Node-B's 22-32 (shown only with respect to Node-B 26 and Node-B 28 for clarity), and administers and manages the parts of the cellular telephone communication system 60, as will be understood by those skilled in the art.

In this embodiment, the RNC's 36, 38, 40 have been adapted, by provision of a handover preparation module, to offer, and provide for, adaptation of transmission characteristics before handover from one radio link to another, as will be described in more detail below.

However, this adaptation may be implemented in any suitable manner to provide suitable apparatus. The module may consist of a single discrete entity added to a conventional RNC, or may alternatively be formed by adapting existing parts of a conventional RNC, for example by reprogramming of one or more processors therein. As such the required adaptation may be implemented in the form of processor-implementable instructions stored on a storage medium, such as a floppy disk, hard disk, PROM, RAM or any combination of these or other storage media. Furthermore, whether a separate entity or an adaptation of existing parts or a combination of these, the module may be implemented in the form of hardware, firmware, software, or any combination of these.

It is also within the contemplation of the invention that such adaptation of transmission characteristics may alternatively be controlled, implemented in full or implemented in part by a module added to or formed by adaptation of any other suitable part of the communication system 60. For example, this may be implemented instead at the node-B's 22-32 when the node-B's 22-32 are combined base station controllers-base transceiver stations, and as such serve more than one cell, or in MSC 42. Further, in the case of other network infrastructures, implementation may be at any appropriate switching node such as any other appropriate type of base station, base station controller etc. Alternatively the various steps involved in determining and carrying out such adaptation (as will be described in more detail below) can be carried out by various components distributed at different locations or entities within any suitable network or system.

In the present embodiment, a communication link is established from a sending terminal, not shown in FIG. 1, (which in this embodiment is an internet website server) connected to a receiving terminal, namely MS 66, (which in this embodiment is a mobile telephone capable of accessing website servers via the internet), via the external network, in this case the internet, 34, the MSC 42, the RNC 36, the I_{ub} interface 35, Node-B 22 and finally the radio link 18. The network protocol for the transmission of data over this communication link is, in this embodiment, IP. Also, a congestion reduction protocol, in this embodiment TCP, is running on top of the network protocol.

For clarity, further description will be made with reference to FIG. 2 which illustrates only those components present in this overall communication link which are relevant to the understanding of this embodiment.

FIG. 2 shows the sending terminal 70, with its use of TCP schematically represented by TCP indication 72, coupled to RNC 36. RNC 36 contains a handover preparation module 73 implemented in this embodiment, as mentioned above, as a discrete module added to a conventional RNC. The RNC 36 is coupled to the current Node-B 22 via I_{ub} interface 35. Current Node-B 22 is coupled to the receiving terminal 66 (MS 66) via the current radio link 18, i.e. receiving terminal 66 is currently in the cell served by current Node-B 22. Receiving terminal 66 employs TCP as schematically indicated by TCP indication 74.

In this embodiment sending terminal 70 is sending website data over the above described communication link to the receiving terminal 66. The current bit-rate available for this, i.e. from Node-B 22, is in this embodiment 100 kbit/sec. FIG. 2 also shows another Node-B, namely Node-B 24, coupled to RNC 36. Let us assume RNC determines, using the procedures specified under UMTS, that, due to say movement of the receiving terminal 66 away from the

Node-B 22 and toward the Node-B 24, that the communication link will need to be handed over from Node-B 22 to Node-B 24. That is, current radio link 18 will need to be replaced with a new radio link 76 from Node-B 24.

FIG. 3 is a flowchart illustrating the process steps carried out by the handover preparation module 73 in this embodiment in order to prepare for the above described handover.

At step 5, the handover preparation module 73 determines, by interrogating the main processing function of RNC 36 (which itself learns from conventional signalling and control protocols carried out between it and Node-B 22) that handover to Node-B 24 is to occur.

At step 10 the handover preparation module 73 determines the bit-rate currently being employed for the transmission on radio link 18, by interrogating Node-B 22. The value in this example is 100 kbit/sec.

At step 15 the handover preparation module 73 determines, by interrogating Node-B 24, the bit-rate that will be employed for the impending transmission on the new radio link 76 to be provided by Node-B 24. The value in this example is 10 kbit/sec.

At step 20 the handover preparation module 73 compares the two determined bit rates. Since a change of bit-rate is to occur, the RNC 36 adjusts the current value of a transmission characteristic which influences the sending terminal's operation with respect to the TCP protocol, to one which will be more suitable for the new radio link 76. In the present embodiment the transmission characteristic that is adjusted is the bit-rate itself. The handover preparation module 73 adjusts the bit-rate gradually over a period of, in this example, 5 seconds, from the current 100 kbit/sec down to 10 kbit/sec, according to a time-profile shown (merely qualitatively) in FIG. 4. More particularly, FIG. 4 shows a plot 80 of the bit-rate allocated to connection from the current base station (i.e. Node-B 22) against time, which is gradually reduced over time to the value x kbit/sec (in this example 10 kbit/sec) shown by dotted line 82, i.e. the bit-rate in cell of the new base station (i.e. Node-B 24). In this embodiment handover is not actioned until the bit-rate is fully reduced to the available level on the new radio link (as indicated by dotted line 84 which shows that handover may occur when the bit-rate has been reduced to the required level), thus providing substantially full avoidance of false triggering of the TCP protocol's congestion response. However, in other embodiments a lesser degree of adjustment to the impending new radio link may be employed, and this would still provide some degree of alleviation of erroneous effects under the congestion reduction protocol employed in such embodiments.

In this embodiment the handover preparation module 73 implements adjustment of the bit-rate by instructing the RNC 36 to physically control the rate at which it forwards the relevant transmission data to the Node-B 24, but could alternatively do this by instructing another communication unit in the communication link, e.g. the SGSN 44 or any other router or GPRS switching node (not shown), to limit the bit-rate.

Because the bit-rate available to the sending terminal 70 has gradually been reduced, the TCP re-transmission time-out window will have been given time to increase and congestion avoidance should not be invoked when handover occurs.

If in this embodiment a new cell can support a higher rate than the current cell, the bit-rate in the current cell is correspondingly increased (if other system constraints allow) so that when the handover has been achieved to the high rate cell, there is no (or a reduced) bit rate ramping period to be undertaken in the new cell (thereby enabling the terminals to use the higher rates available in the new cell as soon as possible, which may be useful in some circumstances).

Also, the roles of the two terminals can be reversed and the embodiment still implemented, that is when terminal 70 is in fact receiving data transmitted from terminal 66, as the effects of handover from radio link 18 to radio link 76 apply equally in the reverse transmission direction.

In a second main embodiment, the transmission characteristic which influences the sending terminal's operation with respect to TCP and which is varied over time at step s25 is the duration between the forwarding of TCP ACK's to the sending terminal i.e. the delay imposed by the communication system when sending TCP acknowledgements to the sending terminal. This is illustrated schematically in FIG. 5, which shows an increase in the delay between ACK's 90, 91, 92, 93, 94 being forwarded. FIG. 5 is merely a qualitative representation - in this embodiment the delays are increased from approximately 20 ms to 200 ms.

This has the effect of 'tricking' the sending terminal, under TCP, to act as if the amount of congestion is increasing (even though in practice it might not be). When the duration between TCP ACK's matches that which would be seen in the more highly congested new cell then the interval between ACK's need be increased no further. Alternatively, handover may be allowed before full adjustment is made, as this will still provide some degree of improved performance.

In other embodiments employing other congestion reduction protocols other than TCP, a suitable parameter employed in the congestion reduction protocol to assess a level of congestion (i.e. corresponding to the ACK delay in the case of TCP above) may be varied accordingly.

As was the case with the first embodiment (where bit-rate was adjusted), in this second main embodiment (where the delay imposed by the communication system when sending TCP acknowledgements to the sending terminal is varied) the roles of the two terminals can be reversed and the embodiment still implemented, that is when terminal 70 is in fact receiving data transmitted from terminal 66, as the effects of handover from radio link 18 to radio link 76 apply equally in this reverse transmission direction.

In the above embodiments the transmission characteristic (e.g. the bit-rate or the ACK delay) was adjusted gradually/smoothly over time. In other embodiments the adjustment can be implemented in a step fashion, comprising two or more steps. Although not allowing such smooth adaptation, this nevertheless allows the sending terminal to be prepared more gently for handover than would be the case if no adjustment at all were made.

In the above embodiments, both the current cell and the new cell were 3G cells, albeit ones supporting different bit-rates. In other embodiments, one cell may be a 3G cell and the other cell a 2G cell, e.g. a GSM cell. Indeed, such embodiments would usually entail a significant difference in available transmission bit-rates between the two types of cell, thus benefiting from the present invention.

In the above embodiments only one of the two terminals is a mobile terminal served by a radio link which might be handed over. However, the present invention is also applicable when both terminals are mobile terminals, each served by a respective current radio link, and wherein the adjustment of transmission characteristic is applied according to the requirements of whichever of the current radio links is to undergo handover.

In the above embodiment, the receiving terminal is a mobile telephone. In other embodiments other types of mobile terminals or mobile stations can be employed instead or as well, such as personal computers with radio modems, electronic organizers, video players, audio players, etc.

It will be understood that the communication system, apparatus and method for preparing for hand-over described above tend to provide the following advantages:

(i) Improve throughput and quality of service on a connection as a user moves and hands-off between cells

(ii) Improve radio resource utilisation. Unnecessarily severe backing off in bit rate (as results when congestion avoidance kicks in) will result in radio resource not being used as fully as possible.

The present invention finds particular application in wireless communication systems such as the UMTS or GPRS systems. However, the inventive concepts contained herein are equally applicable to alternative fixed and wireless communication systems. Whilst the specific, and preferred, implementations of the present invention are described above, it is clear that variations and modifications of such inventive concepts could be readily applied by one skilled in the art.

Claims

1. A method of operating a communication system providing a communication link between a sending terminal and a receiving terminal, wherein one of the terminals is a mobile terminal served by a first radio link forming part of the communication link, and the communication system employs a congestion reduction protocol which provides a congestion reduction mechanism by modifying transmission rates, the method comprising:
determining that a handover is to occur such that the first radio link will be replaced by a second radio link;
determining the bit rate available using the first radio link;
determining the bit rate which will be available using the second radio link;
comparing the determined bit rates;
in response to the comparison, adjusting over time a current value of a transmission characteristic being used for the first radio link and which influences the sending terminal's operation with respect to the congestion reduction protocol to an adjusted value of the transmission characteristic, where the adjusted value is one which will be more suitable for the second radio link than the current value would be.

2. A method according to claim 1, wherein the congestion reduction protocol is the Transmission Control Protocol, TCP.

3. A method according to claim 1 or 2, wherein the step of adjusting over time a current value of a transmission characteristic comprises adjusting the value smoothly over time.

4. A method according to claim 1 or 2, wherein the step of adjusting over time a current value of a transmission characteristic comprises adjustment in two or more steps.

5. A method according to any preceding claim, wherein the transmission characteristic which is varied is the bit rate.

6. A method according to any of claims 1 to 4, wherein the transmission characteristic which is varied is a parameter employed in the congestion reduction protocol to assess a level of congestion.

7. A method according to claim 6 when dependent from claim 2, wherein the parameter employed in the congestion reduction protocol is the delay imposed by the communication system when sending TCP acknowledgements to the sending terminal.

8. A method according to any preceding claim, wherein the congestion reduction protocol is running on top of a network protocol, for example the internet protocol (IP).

9. A method according to any preceding claim, wherein the first radio link is in a first cellular communication

cell and the second radio link is in a second cellular communication cell.

10. A method according to claim 9, wherein at least one of the cellular communication cells is part of a General Packet Radio Service (GPRS), network, or a third generation (3G), cellular communication network, for example a Universal Mobile Telephone Standard (UMTS) cellular communication network.

11. A method according to claim 10, wherein the other cellular communication cell is part of a second generation (2G), cellular communication network, for example a Global System for Mobile Communications (GSM) cellular communication network.

12. A method according to any preceding claim, wherein the step of adjusting the value of the transmission characteristic is performed by a switching node, for example a base site controller of the communication system.

13. A method according to claim 12 when dependent from claim 10, wherein the switching node is a Radio Network Controller (RNC), or a Serving GPRS Support Node (SGSN).

14. A method according to any preceding claim, wherein both terminals are mobile terminals, each served by a respective first radio link, and wherein the method steps are applied according to the requirements of whichever of the first radio links is to undergo handover.

15. Apparatus for a communication system, wherein the communication system is operable to provide a communication link between a sending terminal and a receiving terminal, and one of the terminals is a mobile terminal served by a first radio link forming part of the communication link and the communication system employs a congestion reduction protocol which provides a congestion reduction mechanism by modifying transmission rates; the apparatus characterised by:
means for determining that a handover is to occur such that the first radio link will be replaced by a second radio link;
means for determining the bit rate available using the first radio link;
means for determining the bit rate which will be available using the second radio link;
means for comparing the determined bit rates; and
means for adjusting over time, in response to the comparison, a current value of a transmission characteristic being used for the first radio link and which influences the sending terminal's operation with respect to the congestion reduction protocol to an adjusted value of the transmission characteristic, where the adjusted value is one which will be more suitable for the second radio link than the current value would be.

16. Apparatus according to claim 15, wherein the congestion reduction protocol is the Transmission Control Protocol, TCP.

17. Apparatus according to claim 15 or 16, wherein the means for adjusting over time a current value of a transmission characteristic are arranged to perform adjustment of the value smoothly over time.

18. Apparatus according to claim 15 or 16, wherein the means for adjusting over time a current value of a transmission characteristic are arranged to perform adjustment of the value in two or more steps.

19. Apparatus according to any of claims 15 to 18, wherein the transmission characteristic which is varied is the bit rate.

20. Apparatus according to any of claims 15 to 18, wherein the transmission characteristic which is varied is a parameter employed in the congestion reduction protocol to assess a level of congestion.

21. Apparatus according to claim 20 when dependent from claim 16, wherein the parameter employed in the congestion reduction protocol is the delay imposed by the communication system when sending TCP acknowledgements to the sending terminal.

22. Apparatus according to any of claims 15 to 21, wherein the communication system runs the congestion reduction protocol on top of a network protocol, for example the internet protocol (IP).

23. Apparatus according to any of claims 15 to 22, wherein the first radio link is in a first cellular communication cell and the second radio link is in a second cellular communication cell.

24. Apparatus according to claim 23, wherein at least one of the cellular communication cells is part of a General Packet Radio Service (GPRS), network, or a third generation (3G) cellular communication network, for example a Universal Mobile Telephone Standard (UMTS) cellular communication network.

25. Apparatus according to claim 24, wherein the other cellular communication cell is part of a second generation (2G) cellular communication network, for example a Global System for Mobile Communications (GSM) cellular communication network.

26. Apparatus according to any of claims 15 to 25, wherein both terminals are mobile terminals, each served by a respective first radio link, and wherein the plural determining means, comparing means and adjusting means are arranged to be applied according to the requirements of whichever of the first radio links is to undergo handover.

27. A communication unit, for example a switching node, base station, base site controller, Radio Network Controller (RNC), or a Serving GPRS Support Node (SGSN), of a communication system, comprising the apparatus according to any of claims 15 to 26.

28. A communication system comprising the apparatus according to any of claims 15 to 26.

29. A method of preparing for handover from a first radio link to a second radio link in a cellular communication network, comprising adjusting over time a current value of a transmission characteristic being used for the first radio link and which influences a sending terminal's operation with respect to a congestion reduction protocol to a value of the transmission characteristic adjusted for the second radio link.

30. A method according to claim 29, wherein the congestion reduction protocol is the Transmission Control Protocol (TCP).

31. A communication unit operable to perform the steps of any of claims 1 to 14, 29, 30.

32. A storage medium storing processor-implementable instructions for controlling a processor to carry out the method any of claims 1 to 14, 29, 30.

33. A method of operating a communication system substantially as hereinbefore described with reference to and/or as illustrated in the accompanying Figures.

34. A communication system substantially as hereinbefore described with reference to and/or as illustrated in the accompanying Figures.

35. Apparatus for a communication system substantially as hereinbefore described with reference to and/or as illustrated in the accompanying Figures.

Application No: GB 0104171.4
Claims searched: 1-34

Examiner: Richard Gregson
Date of search: 3 December 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): H4L (LRPMG, LRPML, LRPMS, LRPMW)

Int Cl (Ed.7): H04Q (7/38)

Other: Online: EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2330485 A	(MOTOROLA) - see whole document.	n/a
A	US 6018662 A	(MCGREGOR & PERIYALWAR) - see whole document.	n/a

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		