(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 July 2003 (03.07.2003)

PCT

(10) International Publication Number
WO 03/055167 A1

(51) International Patent Classification[7]: H04L 29/06, 12/56, H04Q 7/38

(21) International Application Number: PCT/EP01/15180

(22) International Filing Date: 21 December 2001 (21.12.2001)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI,

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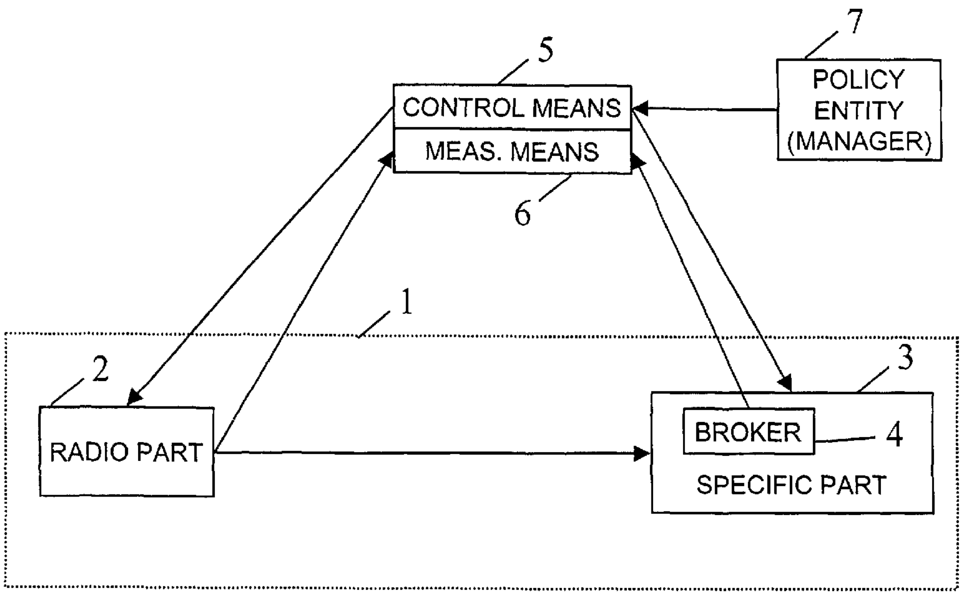
(54) Title: TRAFFIC CONTROL IN AN IP BASED NETWORK



(57) Abstract: According to the present invention, traffic control in an IP based network is provided. For this purpose, traffic situation in the network is measured, and the traffic flow is controlled on the basis of the measured traffic situation. Moreover, an operator may define rules for different measured situations, and the traffic flow is controlled on the basis of these rules.

WO 03/055167 A1

SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TRAFFIC CONTROL IN AN IP BASED NETWORK

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to a method and a system for providing traffic control in an IP (Internet Protocol) based mobile network. In accordance with a more detailed aspect, the invention relates to All-IP RAN, in particular to IP Transport Manager interfaces in All-IP RAN.

Future mobile networks will increasingly be based on packet-based, in particular IP (Internet Protocol), technology in their transport. IP offers flexibility and savings for the operators in building fixed connections for several different purposes.

However, the IP packet based transport network is a challenge from the QoS (Quality of Service) point of view. Operators aim at achieving a high utilization rate of the low capacity transport links close to the base stations while at the same time maintaining the planned QoS and service differentiation levels so as to provide appropriate service at acceptable economic and equipment level.

If the traffic is allowed to flow to the IP transport of the mobile network freely like in the Internet, especially the thin, i.e. low-capacity or low-bandwidth transport parts close to the base stations may tend to become congested, resulting in very low quality of the user experienced QoS. The thin transport part is often based on radio links and copper instead of fiber which may then be available after this "last mile". This thin part is often the biggest part in volume because a mobile network usually is nation wide. However, in some cases, depending on operator's situation it is possible that the thin part occurs also in the very core of the network. Thin in this case means available transport bandwidth with respect to traffic volume.

SUMMARY OF THE INVENTION

It is an object of the present invention to solve or alleviate the above problems and to provide for a dynamic traffic control, preferably QoS control in an IP based network.

According to the present invention this object is achieved by a system according to the independent system claim and/or a method according to the independent method claim. Moreover, the invention provides a measuring device according to the independent measuring device claim, a control device according to the independent control device claim and a policy entity according to the independent policy entity claim.

According to the present invention accurate IP traffic data can be obtained and the traffic flow can be controlled on the basis of the traffic data using wireless mechanisms. Hence, there is no need for the use of signalling mechanisms such as RSVP.

Thus, feedback of IP transport network QoS situation is provided for connection admission control, in particular 3GPP connection admission control.

Information on the bandwidth on routes between gateways (GWs) and Base Transceiver Stations (BTS), that is between pairs of

IP address ranges, may be presented to a control layer, preferably a 3GPP layer, so as to allow a call control, preferably a 3GPP call control, to verify that a new microflow of bandwidth X of Class Y can be admitted.

An IP RAN access network may therefore perform admission control based on QoS feedback from the network.

Further features and advantages of the present invention are defined in the following.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a schematic block diagram illustrating the principle of the present invention,

Fig. 2 shows a feedback loop for controlling incoming traffic flow towards a transport part of an IP based mobile network according to an embodiment of the present invention,

Fig. 3 shows inward interfaces of ITRM,

Fig. 4 illustrates outward interfaces of ITRM,

Fig. 5 is illustrating the interoperation of ITRM and IP bandwidth manager in IP RAN gateway-type elements,

Fig. 6 shows an embodiment comprising several ITRMs which provide admission control interface information that can be used by 3GPP connection admission control,

Fig. 7 illustrates a further embodiment for providing admission control,

Fig. 8 shows an example architecture for available bandwidth notification, with all BTSs connected to a star point, and

Fig. 9 shows information flow between a UE and nodes in an embodiment in accordance with the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

One of the ideas of the invention is to measure traffic situation, e.g. actual traffic situation in an IP based network, e.g. mobile network, and to use the measured data for controlling the incoming traffic flow.

The actual traffic situation may mean or include the traffic situations, topology, and traffic situation data.

In Fig. 1 measuring means 6 are shown which receive traffic data of (a part of) a mobile network 1, which is indicated by a block of dashed lines. Control means 5 shown in Fig. 1 in turn control incoming traffic flow on the basis of the measured traffic data.

The measured traffic data include information regarding the actual traffic load of the network 1, i.e. how many connections are present in the network, and may preferably additionally include information regarding the topology and routing of the mobile network 1, for example. This information can be combined to decide how many connections are allocated to certain specific parts of the network. The topology and routing information may be provided by a broker 4 in a specific part 3 of interest as shown in Fig. 1, such as an IP transport part or a core part of the network. The traffic load information may be provided by the radio part 2 of the network 1.

Moreover, actual traffic situation data within each routing domain of a specific part of the mobile network, such as the transport part can be derived from the measured traffic load on network elements and links and the topology and routing information, and then the means of the mobile network can be used to tune the incoming traffic on the basis of the measured actual traffic situation data.

According to Fig. 1, also a policy entity (or policy manager) 7 is provided. By means of the policy entity 7 the incoming traffic can be tuned to a level desired or set by an operator. This means that the operator can freely choose the QoS level he wants to offer to the subscribers, and at the same time control the utilization rate of the IP transport part of his network.

The control means 5 shown in Fig. 1 may perform incoming traffic flow control at the gateways of the mobile network 1 towards said specific part 3. The control means 5 may provide to each gateway an allowed amount of traffic and priorities to be set for the incoming traffic flow.

In accordance with an aspect of the invention, the two worlds of wireless and IP networks are combined. The invention as described above allows the operator a dynamic control of traffic in the IP transport network, based on the combination of actual traffic situation data as measured from the network and operator settable rules defining allowed network behaviour. Based on actual traffic data in the IP transport network, the system as shown in Fig. 1 is able to manage traffic flow into the transport network by controls used for the wireless layer.

The invention as described above is also applicable to the core part or other part of the mobile network. The invention is not limited to the radio edge, i.e. the radio access network side of a mobile network.

Fig. 2 shows a further embodiment of the present invention. As shown in Fig. 2, a feedback loop starts from IP transport measurements collected by measuring means (measurement part) 6 and ends at the traffic control performed by control means (control part) 5 of the mobile network through gateways (e.g. RNGW 16, CSGW 17) of the network. According to Fig. 2, the measurement part 6 and the control part 5 are located in a control plane 10 of the network.

The measurement part 6 collects load information from a radio part 12 of the network, i.e. from connections for IP access received by an IP BTS (Base Transceiver Station) 11. Moreover, the measurement part 6 collects topology information from a broker in the transport part, which receives data from RNGW (Radio Network Gateway) 16, a CSGW (Circuit Switched Gateway) 17 and an SGSN (Serving GPRS Support Node) 18. As shown in Fig. 2, between the radio part 12 and backbone transport part ("BACKBONE TRANSPORT") there is placed a thin volume part (of low transport capacity) 13 which may often end up being congested as described above. From the backbone transport part traffic data are supplied to a GGSN (Gateway GPRS Support Node) 20 and routed therefrom to the Internet 21.

Routers 14 shown in Fig. 2 provide the necessary routing functions and accesses. A fiber gateway 15 provides connection to a fiber for high-capacity fiber traffic transport.

In Fig. 2 also a policy manager 7 is provided in the mobile network, in which rules can be set for different measured situations. For example, such rules are bandwidth limits, allocation priorities and queuing priorities. Those rules can be set by an operator. The rules are provided to the measurement and control parts 5, 6 of the network and are used to perform control at the gateways of the network towards the transport part, such as the IP BTS, the RNGW and the CSGW. The control part 5 may control gateway resources and set priorities based on the measurements from the measurement part 6 in connection with the rules supplied from the policy manager 7. For example, the control part 5 controls the RAB (Radio Access Bearer) bandwidth, the core bandwidth, the CS (Circuit Switched) lines and sets priorities with respect to the RAB allocation and queuing.

The same functionality as described above can also be applied to the core part of the network although often the situation may be that the operator has sufficiently provided capacity for the core part of the network so that the core part can be managed with slower planning methods and no such dynamic feedback control is needed.

The measurement and control parts 5, 6 of the invention can be placed as software modules into the same running environment with other control plane functionalities of the mobile network and the traffic control can be done through the gateways so that the control plane 10 gives to each gateway the allowed amount of traffic and priorities to be set for different incoming traffic flows.

The embodiments of the invention described in the following refer, among others, to interfaces of IP Transport Manager, in particular IP Transport Resource Manager (ITRM), to network elements in IP RAN (IP-based Radio Access Network).

The invention provides solutions to the problem of relation of admission control of e.g. network elements, e.g. 3GPP (Third Generation Partnership Program) elements, to Quality of Service (QoS) in IP transport in RAN. The use of IP transport in RAN allows to achieve multiplexing gain, and the use of managed DiffServ (Differentiated Services) in IP transport routers in turn makes it possible to consistently prioritize traffic types according to their delay and loss requirements.

The 3GPP layer here refers to Radio Network Layer protocols specified by 3GPP, including RANAP as well as RRC protocols. An interface between ITRM and "3GPP" layer (i.e. the RNL) is not part of 3GPP standard today.

Due to presence of I_{UR} traffic in IP RAN, there can be variations in the volume of priority traffic. For this and other reasons, it is desirable to have a link between connection admission control and feedback from IP network QoS situation to simultaneously address, and comply with, network usage level and QoS requirements of critical traffic types.

The ITRM, e.g. as described and shown in the above and below described embodiments, provides a way of obtaining high-level view of QoS in IP RAN transport QoS, raising the abstraction level from single network elements to routes between elements.

In accordance with preferred embodiments of the invention, information on the bandwidth between pairs IP address ranges (IP host address ranges of GWs between BTS and GW site) is presented to the 3GPP layer, so that 3GPP call control can readily verify that a new microflow of bandwidth X of Class Y can be admitted.

The invention describes a method for providing feedback of IP transport network QoS situation for 3GPP connection admission control.

An advantage of using IP QoS feedback in admission control in accordance with embodiment of the invention is that utilization level of IP transport network links can be maintained at a higher level than would be possible without such a scheme.

The invention can e.g. be used in IP RAN access network for controlling admission control based on QoS feedback from network. In general, similar principle can also be used for more general admission control purposes.

The interface between 3GPP gateway-type elements and measurement modeller supports feedback to admission control based on IP QoS.

The invention can e.g. be used in IP RAN products.

In HSDPA (high speed downlink packet access) concept, a new MAC (Medium Access Control) entity, MAC -hs, has been defined to the network in order to support new capabilities. It is located in Node B. Due to this new entity a functional split between Node B and RNC has been reorganized. Upon this reorganization the scheduling/priority handling and the TFC (Traffic Flow Control) selection functions have been removed from SRNC to node B. However the current DCSH FP frame structure (DSCH FP = Downlink Shared Channel Frame Protocol) for Iub is not applicable for HSDPA data transmission, since there is unnecessary information, which assume TFC selection and scheduling performed. On the other hand DSCH FP frames lack information, which needs to be added in order to support flow control between RNC and node B. Thus, in accordance with preferred embodiments, the invention presents a new FP frame structure or data structure on data transmission on Iub.

Basically new fields are provided in order to guarantee that the flow control mechanisms work when e.g. the MAC entity MAC-hs is located in node B:
New fields are e.g: NumOfSDUs- this field is required to identify the number of the MAC;-hSDUs in the frame and User Buffer size- this field is used to indicate the status of the buffer in RNC buffers (in bytes). This field informs the node B, how much data belonging to the same data flow is still left in RNC. The node B may use this information e.g. in scheduling so that data traffic having highest priority and highest amount of data in RNC buffer gets access to the HSDPA channel earlier than a flow which has low priority and a small amount of data.

Additionally the set of new field may contain UE Id type and a Common Transport Channel Priority Indicator (CmCH-PI).

If multiplexing is allowed a set of further fields is provided like
NumOfBuff- this field indicates how many RNC buffers data has been applied into this FP frame and finally
Size of MAC SDU.

The structure of the needed frame may also depend on whether or not several mobiles can use one Iub tube (i.e: AAL2 connection).

As mentioned above, information on the bandwidth between pair IP address range (IP host addresses of GWs between BTS and GW site) is presented to the 3GPP layer, so that 3GPP call control can readily verify that a new microflow of bandwidth X of Class Y can be admitted.

The IP transport resource manager (ITRM) is responsible for dynamically updating this bandwidth information for the BTSs to use. However, there is no actual resource reservation as such inside the network for any given BTS and therefore such a method leads to maximum trunking gain (statistical multiplexing among BTSs). An advantage of this approach is that the complexity of the routed network is hidden from the 3GPP layer call control, and call control can readily take place with the bandwidth information presented to it locally for that BTS. In addition the method and system does not require the use of signalling mechanisms such as RSVP in the IP network. It is also possible to use the disclosed method to decrease processing requirements of ITRM.

The relevant interfaces are those related to connection admission control, and IP router functionalities in the network. These are described below.

The interfaces from which ITRM gains information are:

Router notification interface.
Topology monitoring interface.
SNMP polling interface.
Interface towards Radio Network admission control.
Interface towards Management system.

These input interfaces are illustrated in Fig. 3.

Fig. 3 shows several cells 32 each having an IP BTS and a router, an ITRM, a radio resource control 30, a policy manager 7, an access gateway 33, a site router 35, and a RAN GW 36. All these components are connected to, or communicate with, the ITRM 31, as represented by the dotted lines. In

Fig. 3, those interfaces where both router notification and SNMP polling interfaces are available, are represented by dot-and-dash lines. These interfaces are in particular present in the routers close to the IP BTSs, in the Access gateway (GW) 33, and in the RAN GW 36. The site router 35 interface where only SNMP polling can be assumed is encircled by a dot-and-dash line with two dots each. The backbone between the Access gateway and the site router as well as the RAN GW is formed by a regional fibre loop 34.

The outward interfaces from ITRM 31 are as follows:

Interface for configuring DiffServ and MPLS PIBs in IP elements. The same interface can be used for elements of different vendors/providers,

Interface for providing information for connection admission control. This interface is towards gateway-type elements such as IP BTS and RAN GW 36,

Interface for providing notifications of QoS status changes in IP Transport,

Interface towards to management system,

Fig. 4 illustrates the same basic structure and topology of the networks and entities as in Fig. 3, and shows the outward interfaces of ITRM 31. IP and MPLS (Multi Protocol Label Switching) configuration interfaces (between ITRM and BTSs, RAN GW) are drawn in dotted lines, admission control interfaces (between ITRM 31, Policy manager 7, cell routers, site routers 35, and access gateway 33) in dashed lines, and QoS notification interface (between ITRM 31 and Radio resource control 30) in dot-and-dash line.

The ITRM 31 uses appropriate data processing algorithms for information processing.

In accordance with an aspect of preferred embodiments of the invention, the invention relates to the second outward interface listed above, i.e. the admission control interface. The details of that admission control interface are described below.

The general framework of admission control is illustrated in Fig. 5. Fig. 5 shows a schematic drawing illustrating the interoperation of ITRM 31 and IP bandwidth manager in IP RAN gateway-type elements.

The ITRM shown in Fig. 5 comprises a Control software (SW) module having a Central IP Transport Bandwidth Manager (IP Tr bw Mgr) a bandwidth control element or function, a Differentiated Services (DS or DiffServ) Tuning element or function, and a report storage element or function. The ITRM shown in Fig. 5 further comprises a Baseband software module (BB SW) having Topology, Routing and Bookkeeping elements or functions.

Further, Fig. 5 shows one of the BTSs, a RNGW (RAN Gateway), a CSGW (Circuit-Switched Gateway), each including a Local IP Transport Bandwidth Manager (IP Tr bw Mgr), IP Routers, an Operation and Administration (Maintenance) System OMS, the Policy Manager, and the interaction and message flows between these components. The message flows are represented by arrows, single-headed arrows symbolizing unidirectional flow, and double-headed arrows symbolizing bidirectional flow.

The Central IP Transport Bandwidth Manager (IP Tr bw Mgr) and the local IP Transport Bandwidth Managers (IP Tr bw Mgr) bi-directionally commmunicate with each other, as shown by the drawing. The IP routers send information, e.g. OSPF/ISIS/BGP, on Topology, and Routing info, to the Topology and Routing elements or functions, which forwards the information to the

Bookkeeping element or function. The IP routers further send measurement information on measured delay and loss to the measurements reports storage.

The Bookkeeping element or function further receives, from the Central IP Transport Bandwidth Manager (IP Tr bw Mgr), traffic load information, per traffic aggregate, e.g. per DSCP (DS code point): "Traffic load from each monitored gateway to other monitored GWs, e.g. from A GW to B GW", "QoS level (loss, delay)", and sends, to the BW Control, a notification: "threshold range t exceeded from GW area x to GW area y" when the traffic between some gateways should have exceeded a given threshold range t.

The BW Control further receives from the measurements report storage information on the measured values, and sends to the Control SW information on the bandwidth (in bits per second, bps) to be used for the gateways, and on code point sharing "For GW's on x use: bandwidth w (bps), DS code point share (%)".

The measurements reports storage sends measurement information to the DS Tuning element and to the Policy Manager. The Policy Manager defines the target values of the bandwidth to be used depending on set threshold range t and area x to be served by an element, e.g. gateway, or network, and informs the BW Control on these set target values. The Policy Manager further controls, via OMS, a lock function which may interact with the IP routers by sending information "DiffServ PIB: change".

The DS Tuning element informs the Control SW on "DiffServ: coding".

The method and system illustrated in Fig. 5 and described above preferably apply to at least the control of Conversational class traffic at Iu'-PS, Iur traffic, and all Iu'-CS traffic, all of which are mapped to the EF (Expedited Forwarding) class in the IP transport network. The scheme applies to the lower part of transport network (MWR access), in between RNGW/CSGW and IP BTS.

Although the signaling procedure example is given for RAB establishment, the same working principle can also be used for serving BSGW relocation and Inter-BTS HO (Hand-Off).

The complete Radio Access Bearer assignment procedure for 3GPP is described and shown in Fig. 9.

Some of the key issues in isolated or arbitrarily combined form are:

Checking the availability of IP transport resource should take place as part of Step 5 of Fig. 9, at the time when the location of serving IP BTS and controlling BTS are determined (here both Endpoints of Iu' / Iur tunnel are known).

In the case direct or directed re-try is initiated during RAB establishment, the procedure for serving IP BTS relocation should be followed. If serving BTS and drift BTS are different physical BTSs, then the link capacity of both Iur tunnel and Iu' tunnel should be checked at the same time.

It is not critical where the BSGW selection function physically locates in the IP RAN architecture, the only consideration being that the available logical interface bandwidth must be checked by that function before activating the tunnel. The details of BSGW selection function can be found in [LMDC].

In the following, the ITRM functionality will be described in more detail.

The IP Transport Resource Manager (ITRM) is a logical element of All-IP RAN that is responsible for monitoring topology and loading status of IP transport. A proposed interface description is listed above. For the present purposes, it is sufficient to say that the preferred solution is that QoS feedback from network elements may be based on polling for loading information in the routers or on alarms triggered by per-traffic class loading situation in the routers. Based on the knowledge of topology and loading, ITRM is able to aid 3GPP layer in IP QoS related issues in connection admission control decisions and relocation procedures on per-3GPP traffic class basis. The most scalable solution is not to do IP resource checking for each connection but rather handle aggregates of individual flows.

It is assumed here that there are multiple ITRMs in the network, each responsible for an IP transport region. Such a region can span multiple routing domains. A general schematic about hierarchy of ITRMs is shown in Fig. 6 showing a proposed solution.

In the embodiment of Fig. 6, each routing domain has a Slave ITRM 31, with several slave ITRMs being subordinated to a (master) ITRM 31, as shown. ITRMs 31 provide admission control interface information that can be used by 3GPP connection admission control. Additionally, ITRM provides information to 3GPP connection control on available IP transport resources, such as available bandwidth. These are explained in more detail below.

Admission control interface information is updated based on information of ongoing connections (provided by 3GPP call control) as well as measurements from the routers.

As regards Congestion status information, the format information in the interface is preferably such that a lookup pertaining to QoS situation between two IP address ranges can be made. The IP address range in the IP BTS end represents the IP host adresses in a router interface of the BTS. The determination of the actual IP addresses may be made at the 3GPP call control side of the interface or at the ITRM side of the interface.

When setting up a radio network layer connection e.g. a radio access bearer, the 3GPP call control can use ITRM-supplied information on available IP transport resources of logical interfaces between the corresponding IP BTSs and RAN GWs (and CSGWs).

By available transport resources it is referred here to the information that call control, in particular 3GPP call control, can associate with the needed IP transport resources. For example, the information can be expressed in terms of bandwidth (e.g. kbit/s) and/or required delays and/or packet losses and/or predetermined class information and/or indications (see subsequent explanations to IP transport resource information). Available IP transport resource information should be provided so that 3GPP call control can readily decide whether a new microflow of bandwidth X of Class Y can be admitted. The class corresponds to a traffic aggregate, for example, to the Diffserv class in the IP transport network being identifed by a pre-defined Diffserv codepoint (or DSCPs).

In the most common scenario there is only one logical RNGW. In such case the Iu' IP transport resource information for every IP BTS may contain the IP transport resource of conversational class, including both Iu'-PS and Iu'-CS, for the whole IP BTS.

If there are more than one logical RNGW (e.g. physically located in different Core sites), the available IP transport resource information will be provided for each of the existing Iu' logical interfaces for each IP BTS.

An example of this is given below. A connection (tunnel) needs to be setup between BTSs A, B, and RAN GW (Endpoint C). The user is in Cell under BTS A, and BSGW is proposed to be in BTS B. The user needs connection of 30kbps for Iur between BTS A and B, and 60kbps of Conversational class for Iu' between BTS B and RAN GW (C).

The interface capacities and utilization levels are as shown in Fig. 7 (let us say that this is the direction for downlink direction and that uplink is not a problem). The admission control procedure now checks the information about available bandwidth, which contains the following information:

A→B	Iur	8 Mbit/s	B→A	Iur	1 Mbit/s
B→C	Conv. Iu'	20 Mbit/s	C→B	Conv. Iu'	5 Mbit/s

This information can be provided per traffic type. Based on this information, 3GPP connection admission control knows that there are enough IP resources for admitting the new connection.

Fig. 7 shows two base transceiver stations BTS A, BTS B communicating via Iur interface. The BTS A provides connection to a subscriber as shown in the drawing, and has a capacity of 10 Mbit/s, with 9 Mbit/s being actually used. The BTS B provides connection to a RAN GW 36 via interface Iu' as shown in the drawing, and has a capacity of 40 Mbit/s, with 35 Mbit/s being actually used.

The information in the interface is updated by ITRMs 31 based on two sources:

Traffic report from BSGWs, RNGWs and CSGWs,
Measurements from all the routers.

The IP transport resource information provided in the interface is for per logical interface (IP address range), per Traffic Class, and per IP BTS. There is no need to have any synchronized actions among IP BTSs and ITRM. ITRM will update the data conveyed in the admission control interface whenever is needed, and the 3GPP layer is expected to always use the latest information available in the interface.

Regarding notifications on available bandwidth or other QoS problems, the ITRM additionally provides directed feedback on available IP transport resources to 3GPP call control elements. Such information can be used for triggering handovers, for example. A scalable way of implementing this is inform 3GPP call control elements when predefined bandwidth levels (or other QoS triggers) are exceeded on bottleneck links from the BTS. Conversely, when trigger condition is no longer true, IP BTSs are again informed. Clearly, averaging is desirable to obtain hysteresis, for avoiding the risk of having oscillating system.

Fig. 8 shows an example architecture for available bandwidth notification between several IP BTSs connected to a star point, and an Access Gateway. The other components such as ITRM are not shown in Fig. 8.

For the example architecture shown in Fig. 8, all the IP BTSs connected to the star point as shown are notified of predefined QoS situation (e.g., available bandwidth smaller than X) taking place on the link from star point to access gateway 33.

Regarding IP transport resource information, preferably the most natural form of IP transport resource information is the available bandwidth expressed in terms of data per time unit, e.g. kbit/sec. The proposed interface may also carry some other information as optional or as replacing bandwidth information. Below some examples are given.

Information may be the carried load in % (e.g. utilization of the available link capacity).

Information may include delay parameters, or related usage of provided packet buffers (e.g. maximum or average filling of buffers for each queue),

Information may include packet loss parameters,

Information may be identification of predetermined classes. For example, 3GPP call control may ask "Is there enough resources for another Standard VoIP call". Notice that in this case there is no explicit bandwidth information transferred over the interface,

Information may be a notification. For example, the 3GPP call control may simply send a notification about a new connection without any explicit parameters (not even a class). ITRM can respond based on worst case assumptions about the requirements of the new connection,

Information may be a lack of notification. For example, as long as the 3GPP call control do not receive any alarm notification, it assumes the existence of enough IP transport resources.

Fig. 9 illustrates an embodiment of a Radio Access Bearer Establishment procedure in accordance with the invention.

Between Step 3 and 4, RNAS selects RNGW and Iu' tunnel. Endpoint address of RNGW is known in the RAB assignment message of Step 4.

Checking the availability of IP transport resource preferably takes place as part of Step 5, at the time when the location of serving BSGW is determined (here both Endpoints of Iu' tunnel are known).

In the case direct or directed re-try is initiated, the procedure for serving IP BTS relocation is preferably followed. If serving BTS and drift BTS are different physical BTSs, then the interface capacity of both Iur tunnel and Iu' tunnel is preferably checked.

In the scenario shown in Fig. 9, it is supposed that the UE (user equipment) is in RRC connected mode, so an RRC connection has been previously established in dedicated mode. In case of GERAN, the TBF must be previously established. The message flows and steps shown in Fig. 9 are evident from the drawing providing clear disclosure thereof. In addition, some of the steps and features are described below with reference to the step numbering shown in Fig. 9.

Step 1: CN (Core Network) sends a RANAP *RAB Assignment Request* message to RNAS in order to setup a RAB establishment procedure.

Step 2: The RNAS selects the RNGW (RAN Gateway) used for the establishment of the RABs, and reserves the resources using one RGAP *Reserve Identifier Request* message.

Step 3: Once the resources (TEIDs) have been reserved in the RNGW, it responds to the RNAS using one RGAP *Reserve Resources Identifier Response* message.

Step 4: RNAS provides relay (changing some of the parameters involved) to the RANAP message received in step 1, sending it to the IP BTS using RANAP' *RAB Assignment Request* message. The RNAS knows which IP BTS to select because there is one mapping table UE identifier (IMSI) - UCF in the RNAS.

Step 5: UCF executes then UCF level admission control for the incoming RAB request, by receiving the load measurements from the target BSGW. UCF decides if it is possible to admit the RAB requested by the RAN.
Now, in case that directed retry is initiated, the IP BTS can ask the CRMS to change the cell before establishing the radio link for the new service.

Step 6: In UTRAN case, the serving IP BTS can ask for measurements to the UE by sending one RRC *Measurement Control* message.

Step 7: The UE sends measurements using UTRAN RRC *Measurement Report*. In case of GERAN, the UE sends periodically the RRC *Measurement Report* or *Enhanced Measurement Report* message.

Step 8: The IP BTS can ask now to the CRMS (Common Resource Management Server) to prioritize the candidate cell list sending the *Prioritized Cell List Request* message.

Step 9: The CRMS returns the candidate cell list using the *Prioritized Cell List Response* message.
After the priorization of the cell list, one IP BTS relocation procedure may be initiated if needed. Then, the

RAB establishment procedure continues (in this case it is supposed that the cell chosen is the same where the RRC connection was established).

The user plane (BSGW) is reconfigured in case of UE in RRC dedicated state, and the radio link is also reconfigured.

Step 10: When both c-plane and u-plane are ready for the new RAB, the IP BTS sends a RRC *Radio Bearer Setup* message to UE. Notice that in case of GERAN, the TBF is needed.

Step 11: UE acknowledges the RB setup sending a RRC *Radio Bearer Setup Complete* message to the IP BTS.

Step 12: The IP BTS acknowledges the RAB assignment procedure sending a RANAP' *RAB Assignment Response* message to the RNAS.

Step 13: In the previous message, the RNAS receives the transport address and the TEID assigned by the BSGW for the establishment of the GTP tunnel. Now the RNAS sends these parameters to the RNGW in one RGAP *Add Mapping Request* message.

Step 14: The RNGW sends a RGAP *Add Mapping Response* message to RNAS.

Step 15: The RNAS relay this message to the CN in one RANAP *RAB Assignment Response* message.

While the invention has been described with reference to preferred embodiments, the description is illustrative of the invention and is not to be construed as limiting the invention. Various modifications and applications may occur to those skilled in the art without departing from the scope of the invention as e.g. defined by the appended claims.

CLAIMS

1. A system for providing traffic control in an IP based communication network, said system comprising:

means for measuring traffic situation in said communication network; and

means for controlling traffic flow, on the basis of the measured traffic situation.

2. A system according to claim 1, wherein said measuring means are arranged to measure delay and/or loss of transmitted data.

3. A system according to claim 1 or 2, wherein said measuring means are arranged to measure or detect topology of said network and routing data of said network.

4. A system according to any one of the preceding claims, wherein said measuring means are arranged to combine the measured topology and routing data and the measured traffic load data in order to obtain traffic situation data for a specific part of said network.

5. A system according to any one of the preceding claims, wherein said measuring means are arranged to combine measured topology and routing data and measured traffic load data in order to obtain actual traffic situation data within each routing domain of a specific part of the network.

6. A system according to any one of the preceding claims, further comprising a broker in a specific part of the network for providing the topology and routing data and a radio part for providing the traffic load data to said measuring means.

7. A system according to any one of the preceding claims, wherein said controlling means are arranged to perform incoming traffic flow control at gateways of said network towards a specific part of the network.

8. A system according to claim 7, wherein said controlling means are arranged to provide to each gateway an allowed amount of traffic and priorities to be set for the traffic flow.

9. A system according to any one of the preceding claims, further comprising a policy entity for providing rules to said controlling means, wherein said controlling means are arranged to control the traffic flow on the basis of the provided rules.

10. A system according to claim 9, wherein said policy entity is arranged to provide rules for different measured traffic situations.

11. A system according to claim 9 or 10, wherein the rules are set by an operator.

12. A system according to any one of the preceding claims, wherein specific parts of the network comprise a transport part and a core part of said network.

13. A system according to any one of the preceding claims, wherein information on the bandwidth between IP address ranges, e.g. IP host address ranges of gateways (GWs) between BTS and GW site is presented to a control layer, preferably a 3GPP layer, so as to allow a call control, preferably a 3GPP call control, to verify that a new microflow of bandwidth X of Class Y can be admitted.

14. A system according to any one of the preceding claims, wherein feedback of IP transport network QoS situation is provided for connection admission control, in particular 3GPP connection admission control.

15. A system according to any one of the preceding claims, comprising IP RAN access network controlling admission control based on QoS feedback from the network.

16. A system according to any one of the preceding claims, wherein Frame Protocol (FP) frames, in particular, DSCH FP frames for data transmission on Iub, include information for supporting flow control, preferably between RNC and node B.

17. A system according to claim 16, wherein the FP frames include at least one of the following fields:
a field for identifying the number of a MAC;-hS data unit in the frame,
a field indicating buffer status of one or more RNC buffers and informs node B, how much data belonging to the same data flow is still left in RNC,
a field containing UE Id type and a Common Transport Channel Priority Indicator (CmCH-PI),
a field indicating how many RNC buffers data has been applied into this FP frame,
a field indicating size of MAC SDU.

18. A system according to any one of the preceding claims, wherein an IP transport resource manager (ITRM) is provided which is adapted for dynamically updating bandwidth information for base transceiver stations (BTSs) to use.

19. A system according to any one of the preceding claims, including interfaces related to connection admission control, wherein interfaces from which ITRM gains information include at least one of the following interfaces:

Router notification interface,

Topology monitoring interface,

SNMP polling interface,

Interface towards Radio Network admission control,

Interface towards Management system.

20. A system according to any one of the preceding claims, including interfaces related to connection admission control, wherein interfaces to which ITRM outputs control information include at least one of the following interfaces:

interface for configuring DiffServ and/or MPLS PIBs in IP elements,

interface for providing information for connection admission control, preferably towards gateway-type elements such as IP BTS and RAN GW,

interface for providing notifications of QoS status changes in IP Transport,

interface towards to management system,

21. A system according to any one of the preceding claims, including an ITRM which comprises a Control software (SW) module having a Central IP Transport Bandwidth Manager (IP Tr bw Mgr), a bandwidth control element or function, a Differentiated Services tuning element or function, and a report storage element or function, the ITRM further comprising a Baseband software module having Topology, Routing and Bookkeeping elements or functions.

22. A system according to claim 21, the Bookkeeping element or function being adapted to receive, from the Central IP Transport Bandwidth Manager, traffic load

information, per DS code point, related to traffic load from each monitored gateway to other monitored gateways, and QoS level information (preferably loss, delay), and sends, to the bandwidth Control, a notification when the traffic between some gateways has exceeded a given threshold range.

23. A system according to claim 21 or 22, the bandwidth Control further receiving from the measurements report storage information on the measured values, and sends to the Control software information on the bandwidth (in bits per second, bps) to be used for the gateways, and on code point sharing.

24. A system according to claim 21, 22 or 23, wherein the measurements reports storage sends measurement information to the DS Tuning element and to the Policy Manager, the Policy Manager defining target values of the bandwidth to be used depending on set threshold range and area to be served by an element, e.g. gateway, or network, and informs the bandwidth Control on these set target values.

25. A method for providing traffic control in an IP based communication network, comprising the steps of:

measuring traffic situation in said network; and

controlling traffic flow on the basis of the measured traffic situation.

26. A method according to claim 25, wherein said measuring step measures delay and/or loss of transmitted data.

27. A method according to claim 25 or 26, wherein said measuring step measures or detects actual topology of said network and routing data of said network.

28. A method according to any one of the preceding method claims, wherein said measuring step is arranged to combine the measured topology and routing data and the measured traffic load data in order to obtain traffic situation data for a specific part of said network.

29. A method according to any one of the preceding method claims, wherein said measuring step is arranged to combine measured topology and routing data and measured traffic load data in order to obtain traffic situation data within each routing domain of a specific part of the network.

30. A method according to any one of the preceding method claims, further comprising a broker in a specific part of the network for providing the topology and routing data and a radio part for providing the traffic load data to said measuring step.

31. A method according to any one of the preceding method claims, wherein said controlling step is arranged to perform traffic flow control, preferably incoming traffic flow control, at gateways of said network towards a specific part of the network.

32. A method according to claim 31, wherein said controlling step is arranged to provide to each gateway an allowed amount of traffic and priorities to be set for the traffic flow.

33. A method according to any one of the preceding method claims, further comprising a policy entity for providing rules to said controlling step, wherein said controlling step is arranged to control the incoming traffic flow on the basis of the provided rules.

34. A method according to claim 33, wherein said policy entity is arranged to provide rules for different measured traffic situations.

35. A method according to claim 33 or 34, wherein the rules are set by an operator.

36. A method according to any one of the preceding method claims, wherein specific parts of the network comprise a transport part and a core part of said network.

37. A method according to any one of the preceding method claims, wherein information on the bandwidth between IP address ranges, e.g. IP host address ranges of gateways (GWs) between BTS and GW site is presented to a control layer, preferably a 3GPP layer, so as to allow a call control, preferably a 3GPP call control, to verify that a new microflow of bandwidth X of Class Y can be admitted.

38. A method according to any one of the preceding method claims, wherein feedback of IP transport network QoS situation is provided for connection admission control, in particular 3GPP connection admission control.

39. A method according to any one of the preceding method claims, comprising IP RAN access network controlling admission control based on QoS feedback from the network.

40. A method according to any one of the preceding method claims, wherein Frame Protocol (FP) frames, in particular, DSCH FP frames for data transmission on Iub, include information for supporting flow control, preferably between RNC and node B.

41. A method according to claim 40, wherein the FP frames include at least one of the following fields:
a field for identifying the number of a MAC;-hS data unit in the frame,
a field indicating buffer status of one or more RNC buffers and informs node B, how much data belonging to the same data flow is still left in RNC,
a field containing UE Id type and a Common Transport Channel Priority Indicator (CmCH-PI),
a field indicating how many RNC buffers data has been applied into this FP frame,
a field indicating size of MAC SDU.

42. A method according to any one of the preceding method claims, wherein an IP transport resource manager (ITRM) is provided which is adapted for dynamically updating bandwidth information for base transceiver stations (BTSs) to use.

43. A method according to any one of the preceding method claims, including interfaces related to connection admission control, wherein interfaces from which ITRM gains information include at least one of the following interfaces:
Router notification interface,
Topology monitoring interface,
SNMP polling interface,
Interface towards Radio Network admission control,
Interface towards Management system.

44. A method according to any one of the preceding method claims, including interfaces related to connection admission control, wherein interfaces to which ITRM outputs control information include at least one of the following interfaces:

interface for configuring DiffServ and/or MPLS PIBs in IP elements,

interface for providing information for connection admission control, preferably towards gateway-type elements such as IP BTS and RAN GW,

interface for providing notifications of QoS status changes in IP Transport,

interface towards to management system,

45. A method according to any one of the preceding method claims, including an ITRM which comprises a Control software (SW) module having a Central IP Transport Bandwidth Manager (IP Tr bw Mgr), a bandwidth control element or function, a Differentiated Services tuning element or function, and a report storage element or function, the ITRM further comprising a Baseband software module having Topology, Routing and Bookkeeping elements or functions.

46. A method according to claim 45, the Bookkeeping element or function being adapted to receive, from the Central IP Transport Bandwidth Manager, traffic load information, per DS code point, related to traffic load from each monitored gateway to other monitored gateways, and QoS level information (preferably loss, delay), and sends, to the bandwidth Control, a notification when the traffic between some gateways has exceeded a given threshold range.

47. A method according to claim 45 or 46, the bandwidth Control further receiving from the measurements report storage information on the measured values, and sends to the Control software information on the bandwidth (in bits per second, bps) to be used for the gateways, and on code point sharing.

48. A method according to claim 45, 46 or 47, wherein the measurements reports storage sends measurement information to the DS Tuning element and to the Policy Manager, the Policy Manager defining target values of the bandwidth to be used depending on set threshold range and area to be served by an element, e.g. gateway, or network, and informs the bandwidth Control on these set target values.

49. A method according to any one of the preceding method claims, wherein the traffic flow is the incoming traffic flow.

50. A method according to any one of the preceding method claims, wherein the IP based network is an IP based mobile network.

51. A system according to any one of the preceding system claims, wherein the traffic flow is the incoming traffic flow.

52. A system according to any one of the preceding system claims, wherein the IP based network is an IP based mobile network.

53. A measuring device in an IP based network, said measuring device being arranged to measure traffic situation in said network, wherein the measured traffic situation data are used for traffic flow control.

54. A control device in an IP based network, said control device being arranged to control traffic flow on the basis of traffic situation measured in said network.

55. A policy entity in an IP based network, said entity being arranged to provide rules for traffic situations

measured in said mobile network so that traffic flow is controlled on the basis of the provided rules.

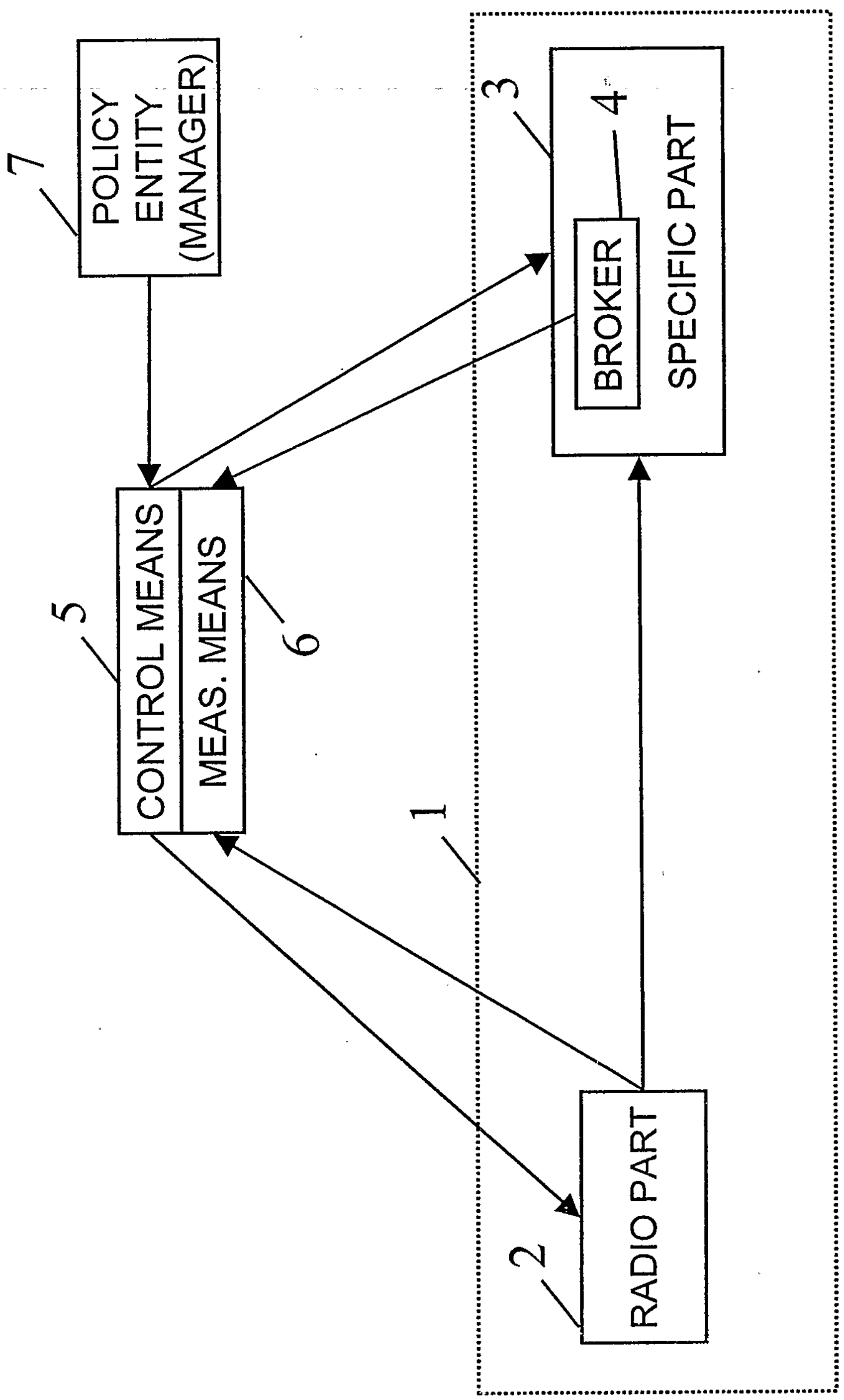
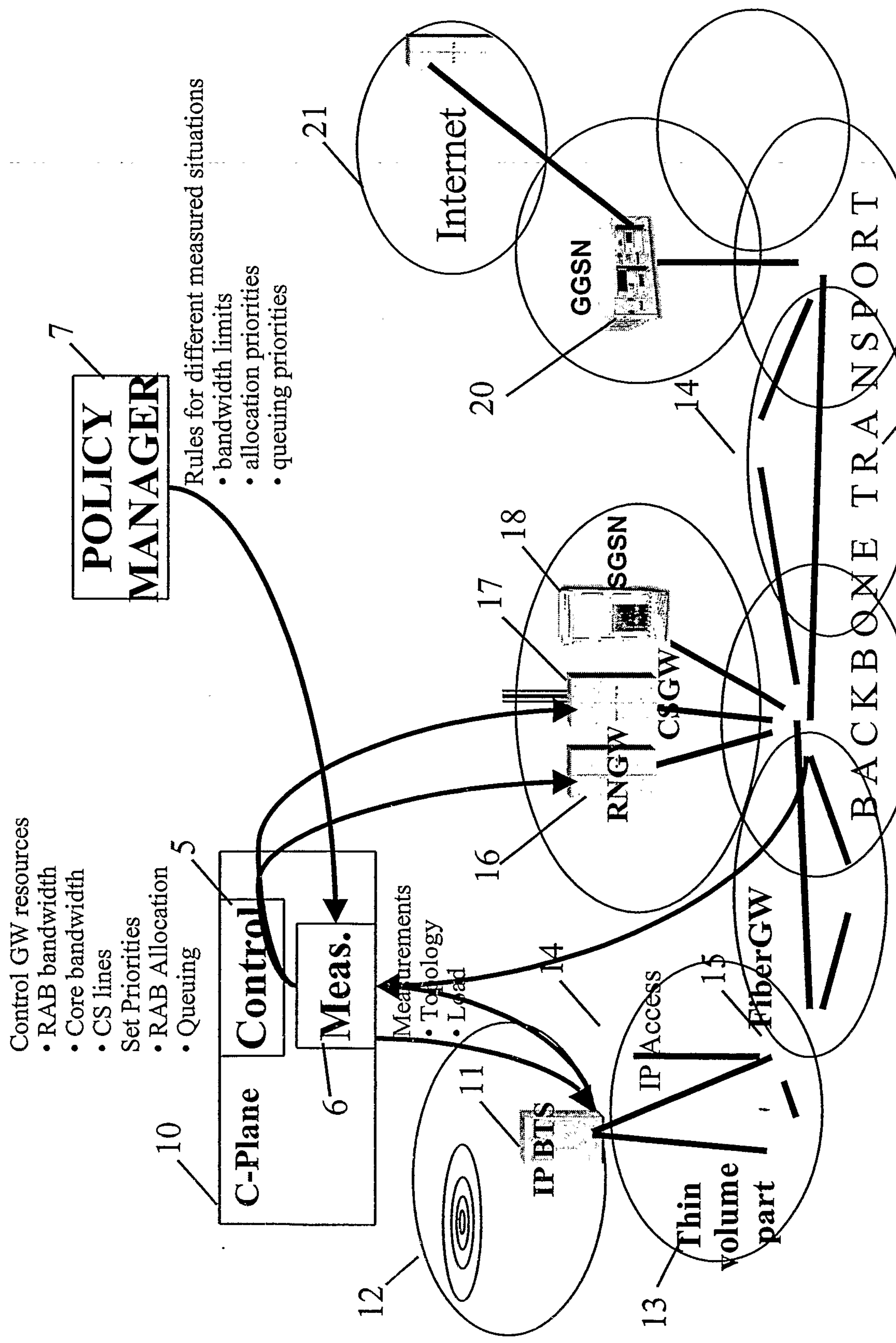

POLICY
ENTITY
(MANAGER)
7
3
4
BROKER
SPECIFIC PART
5
CONTROL MEANS
MEAS. MEANS
6
1
2
RADIO PART

FIG. 1

2/7



POLICY MANAGER
7
Rules for different measured situations
• bandwidth limits
• allocation priorities
• queuing priorities
Control GW resources
• RAB bandwidth
• Core bandwidth
• CS lines
Set Priorities
• RAB Allocation
• Queuing
10
C-Plane
5
Control
Meas.
6
Measurements
• Topology
• Load
12
11
IP BTS
13
Thin volume part
IP Access
14
15
FiberGW
16
RNGW
17
CSGW
18
SGSN
BACKBONE TRANSPORT
19
14
20
GGSN
21
Internet

FIG. 2

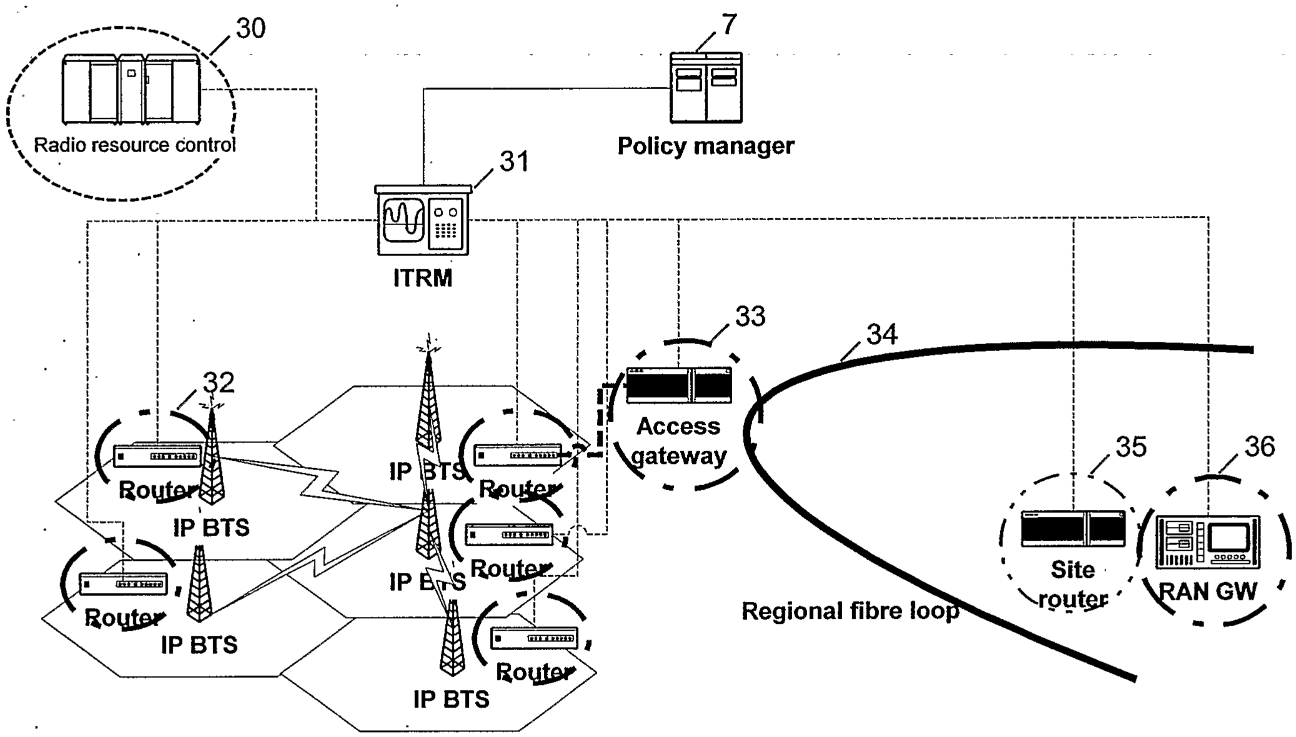


FIG. 3

Inward interfaces of ITRM

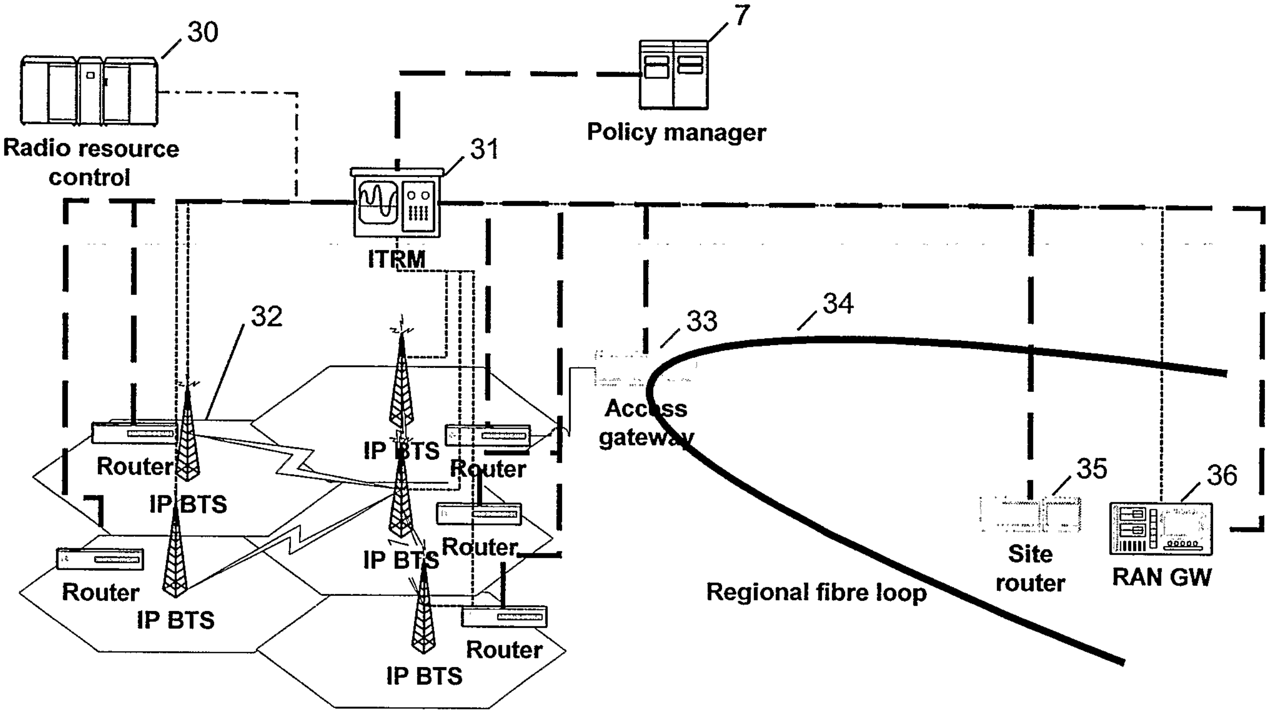


FIG. 4

Illustration of the outward interfaces of ITRM

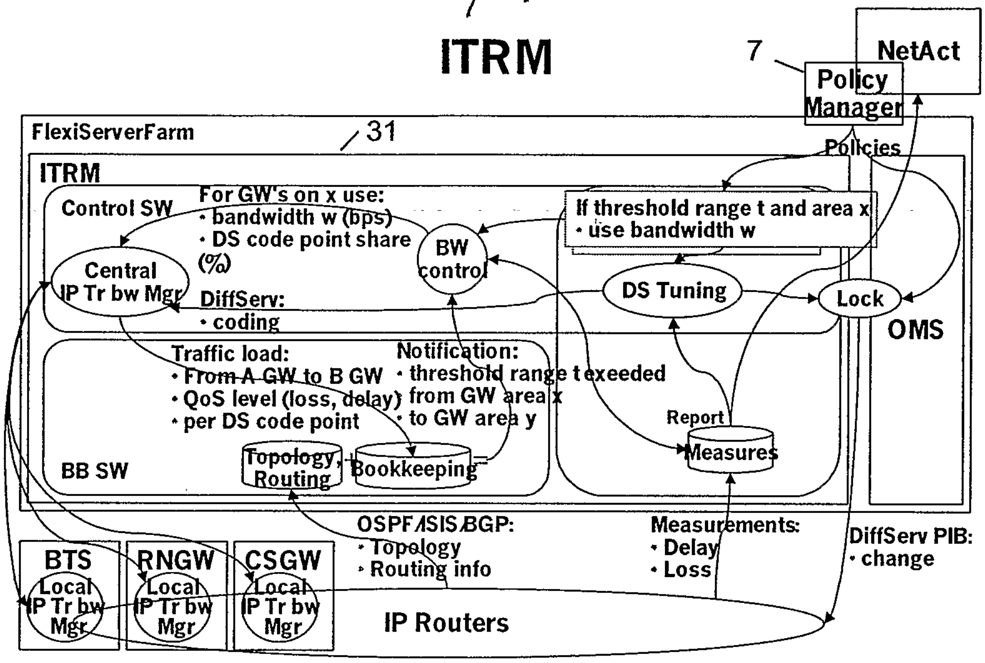


FIG. 5

Illustration of the interoperation of ITRM and IP bandwidth manager in IP RAN gateway-type elements

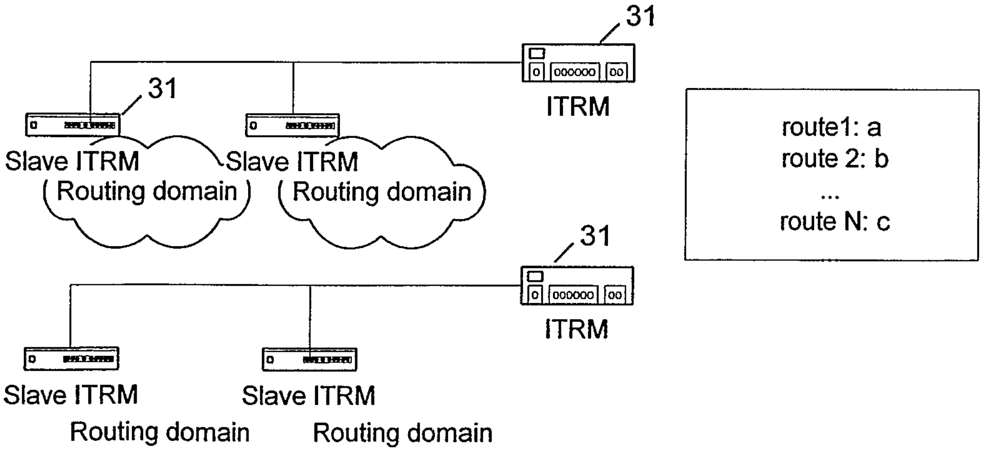


FIG. 6

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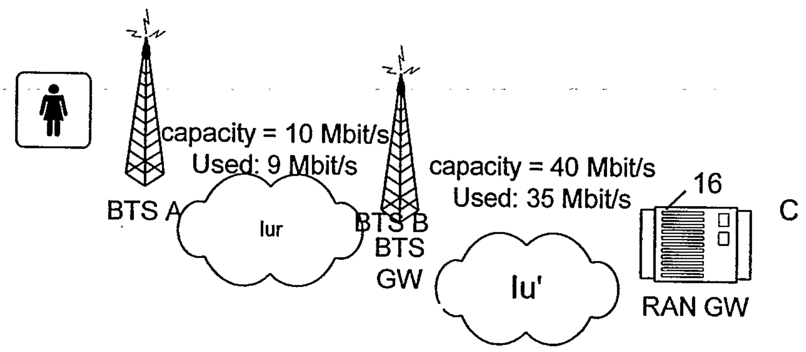

FIG. 7

An admission control example.

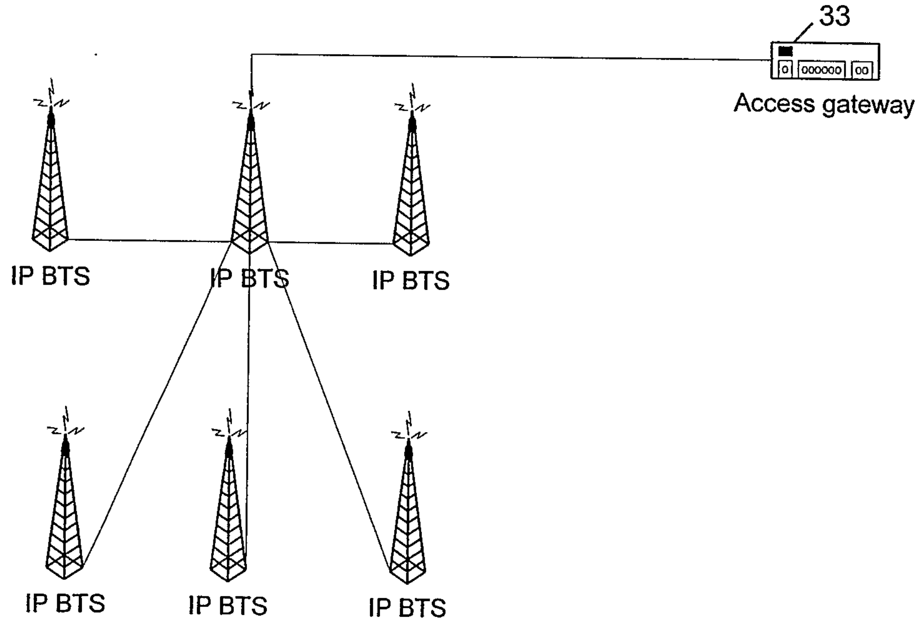

FIG. 8

Example architecture for available bandwidth notification

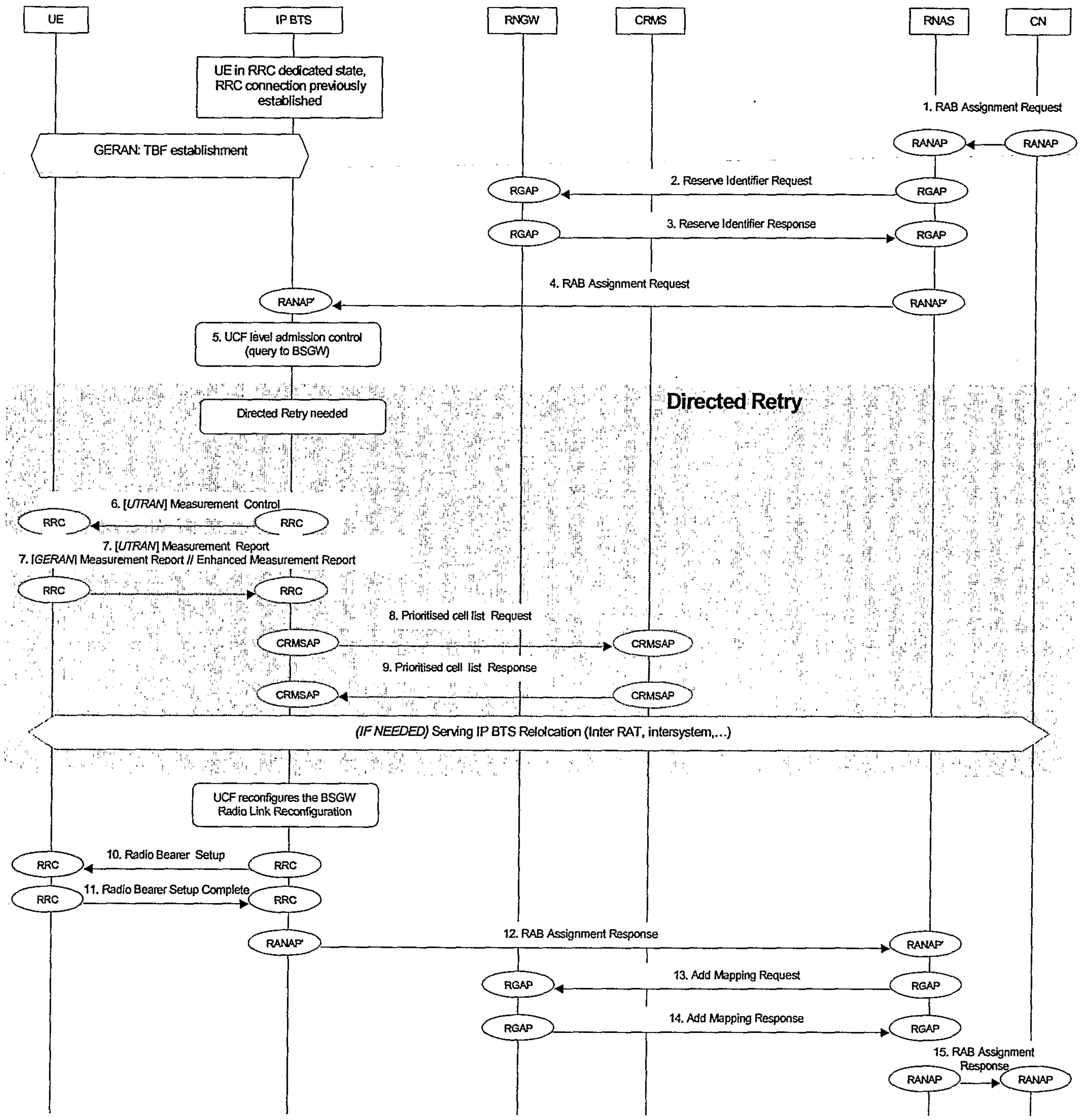
UE
IP BTS
RNGW
CRMS
RNAS
CN
UE in RRC dedicated state, RRC connection previously established
1. RAB Assignment Request
RANAP
GERAN: TBF establishment
2. Reserve Identifier Request
RGAP
3. Reserve Identifier Response
4. RAB Assignment Request
RANAP'
5. UCF level admission control (query to BSGW)
Directed Retry
Directed Retry needed
6. [UTRAN] Measurement Control
RRC
7. [UTRAN] Measurement Report
7. [GERAN] Measurement Report // Enhanced Measurement Report
8. Prioritised cell list Request
CRMSAP
9. Prioritised cell list Response
(IF NEEDED) Serving IP BTS Relolcation (Inter RAT, intersystem,...)
UCF reconfigures the BSGW Radio Link Reconfiguration
10. Radio Bearer Setup
11. Radio Bearer Setup Complete
12. RAB Assignment Response
13. Add Mapping Request
14. Add Mapping Response
15. RAB Assignment Response

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP 01/15180

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04L 29/06, H04L 12/56, H04Q 7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04L, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6137777 A (VAID ET AL), 24 October 2000 (24.10.00), column 9, line 20 - line 29; column 11, line 63 - column 12, line 33; column 12, line 57 - line 58, abstract, column 17, line 57 - column 18, line 4 figure 2 --	1,9,25,33, 49,51,53-55
X	WO 0072516 A1 (MOTOROLA INC.), 30 November 2000 (30.11.00), page 2, line 16 - line 18; page 4, line 2 - line 3; page 6, line 10 - page 9, line 2 --	1-5,7-8,12, 14-15,25-29, 31-32,36, 38-39,49,51, 53-54
A	WO 0013093 A1 (GTE LABORATORIES INCORPORATED), 9 March 2000 (09.03.00), abstract -- --------	1,25,54

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 August 2002	04. 09. 2002
Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Ann Börjeson /js Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

06/07/02

International application No.
PCT/EP 01/15180

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6137777 A	24/10/00	US 6292465 B	18/09/01
		US 6047322 A	04/04/00
		US 6119235 A	12/09/00
		US 6341309 B	22/01/02
WO 0072516 A1	30/11/00	EP 1183822 A	06/03/02
WO 0013093 A1	09/03/00	AU 5694799 A	21/03/00
		EP 1116120 A	18/07/01
		US 6405257 B	11/06/02
		US 2002056007 A	09/05/02