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U.S. Patent 9,838,213

U.S. Patent 9,838,213 ("*Entropic Communications*" or the "patent-at-issue") was filed on February 6, 2008. According to its cover page, the publication claims a priority date of February 6, 2007 on the basis of a prior application. Claim 1 of the patent-at-issue is generally directed to a method including the steps of receiving a first request to initiate a guaranteed quality of service flow in a network, broadcasting a second request from a Network Coordinator to a plurality of nodes connected to the network and receiving a first response to the second request from at least one ingress node. The method further includes receiving a response if the source node and the at least one egress node do not have available resources to support the guaranteed quality of service flow, then denying the guaranteed quality of service flow, and then determining a maximum data rate that would have resulted in a successful request for a guaranteed quality of service flow, and transmitting a message comprising information describing the maximum data rate that would have resulted in a successful request for a guaranteed quality of service flow.

The primary reference, U.S. Patent 7,760,641 ("*IBM*"), was filed on July 10, 2006 and claims priority on the same date. According to its cover page, the publication claims a priority date of March 18, 1999 on the basis of a prior application. The publication is directed to a network comprising a plurality of network resources, and at least one network cluster having a plurality of cluster members. Each member of the cluster may be individually configured for utilizing one or more of the network resources and for tracking usage, which may reside on a single physical machine, or may be distributed across multiple machines. In most cases, the cluster members may be coupled together via a high-speed Local Area Network (LAN). Regardless of topology, each member of the cluster may include traffic shaping software for controlling the distribution of network traffic sent to the network cluster.

The secondary reference, U.S. Pat. App. 20090028141 ("*Orange*"), was filed on September 28, 2005. According to its cover page, the publication claims a priority date of October 8, 2004 on the basis of a prior application. The patent is directed to a method for controlling admission to a guaranteed quality of service in a MPLS network. The patent is characterized in that the input peripheral router receives request from a client for setting up a guaranteed quality of service in the MPLS network, obtains traffic engineering parameters corresponding to the service requested by the client, determines whether the creation of a tunnel for transporting the data flow(s) related to the guaranteed quality of service between the input peripheral router and the output peripheral router is possible in the MPLS network and transfers to the client a message of denial of the request of the client for setting up a guaranteed quality of service in the MPLS network if it is not possible to create a tunnel for carrying the data flow(s) related to the guaranteed quality of service between the input peripheral router and the output peripheral router in the network.

The secondary reference, U.S. Patent 8,711,696 ("*DirecTV*"), was filed on March 12, 2012. According to its cover page, the publication claims a priority date of December 6, 2006 on the basis of a prior application. The patent is directed to a method of data may be transmitted in a broadcast mode to multiple devices operating in a network. Efficient utilization of bandwidth while

providing a desired level of quality of service is enabled for the applications executing on the devices that utilize the broadcasted data. A set of bandwidth constraints may be utilized in combination with a set of heuristics and rules for the allocation and re-allocation of bandwidth among multiple applications in a manner that minimizes the impact on the quality of service metrics of importance to the affected applications when contention exists for the network resources. Quality of service provided to each application may be degraded smoothly, with certain priorities and guarantees being maintained.

A sample claim chart comparing claim 1 of *Entropic Communications* to *IBM*, *Orange*, and *DirecTV* is provided below.

US9838213 ("*Entropic Communications*")	**A. US7760641** (*"IBM"*) **B. US20090028141** (*"Orange"*) **C. US8711696** (*"DirecTV"*)
1.pre A communication method implemented in a **Network Coordinator (NC) node of a communication network** of a premises, the method comprising:	**A. US7760641** "FIG. 2 illustrates one manner in **which a group of application servers (e.g., Application Servers 1-4) may be clustered together across multiple network nodes** (e.g., nodes A and B). In most cases, the network nodes may be coupled across a high-speed LAN, although a WAN may be used in other cases." *IBM* at col. 6:61-66 "Likewise, rate capacity may be released back into the cluster for redistribution, if the estimator determines that the current rate capacity assigned to a cluster member is being underutilized. In most cases, rate capacity is requested and released in chunks to increase speed and cut down on inter-group messaging (which consumes bandwidth on the **communication paths between cluster members**)." *IBM* at col. 8:63-67 through col. 9:1-2 "16. A network comprising: **a network cluster having a plurality of cluster members**, each individually configured for concurrently providing a same application and for tracking usage thereof; and **a reservation coordinator cluster member** for controlling a distribution of traffic rate limits amongst the plurality of cluster members, wherein. . . ." *IBM* at claim 16 **B. US20090028141** "**The network controller** 160 **is able to process the various requests transferred by the ingress edge routers** 100 a and 100 b of the MPLS network 150. The network controller 160 stores the various traffic engineering parameters corresponding to each of the services accessible to the customers 180 and the applicable rules for making available resources of the MPLS network 150." *Orange* at par. 0052 "For example, if the RSVP signaling protocol is used, the ingress router 100 a transmits a Path message in an IP packet to the egress router 120. **This message specifies the list of nodes**

1.pre A communication method implemented in a **Network Coordinator (NC) node of a communication network** of a premises, the method comprising:	110 a, 110 c **through which the LSP path must pass. At each node, the Path message establishes the path and makes a status reservation**. When the Path message reaches the egress router 120, an acknowledgement message Resv is returned by the same path to the ingress router 100 a." *Orange* at par. 0009 **C. US8711696** "In one embodiment, **the invention is implemented in the form of a client-server architecture that includes a Broadcast Server (BS) and a Broadcast Client Toolkit (BCT). Server-side applications that serve data, send notifications, or distribute events register with the Broadcast Server**. Client applications that wish to receive such data, notifications, or events register with the Broadcast Client Toolkit." *DirecTV* at col. 10:52-58
1.a broadcasting to a plurality of nodes of the network, **a request for a guaranteed quality of service flow in the network from a source node to at least one egress node**, the plurality of nodes of the network to which the NC node broadcasts the request including at least the source node and the at least one egress node;	**A. US7760641** "**"Traffic shaping" is often described as an attempt to control network traffic in order to optimize or guarantee performance**, low latency and/or bandwidth. **Traffic shaping algorithms usually deal with concepts of** classification, queue disciplines, policy enforcement, congestion management, **quality of service (QoS)** and fairness. The most common traffic shaping algorithms are the Token Bucket and Leaky Bucket algorithms." *IBM* at col. 2:25-32 "**The improved admission control and traffic shaping algorithms described herein are similar in that each utilizes the key features of a high availability framework**. For example, one member of the cluster is elected "reservation coordinator." As described in more detail below, any member of the cluster may be elected coordinator." *IBM* at col. 8:41-46 "For example, **a cluster member may send a reservation request to the active coordinator for reserving additional rate,** if the estimator determines that additional rate capacity is needed to satisfy the influx of client requests currently being sent to the cluster member." *IBM* at col. 8:58-62 **B. US20090028141** "**At each node, the MPLS routing table is updated and resources are reserved. For example, if the resource is a bandwidth and there is a desire to reserve 10 Mbits for the path**, the bandwidths respectively assigned to each link are

1.a broadcasting to a plurality of nodes of the network, **a request for a guaranteed quality of service flow in the network from a source node to at least one egress node**, the plurality of nodes of the network to which the NC node broadcasts the request including at least the source node and the at least one egress node;	decremented by the reserved value of 10 Mbits on the back-propagation of the acknowledgement/reservation message." *Orange* at par. 0010 **C. US8711696** "As will be described in greater detail, **Broadcast Server** 110 **and Broadcast Client Toolkit** 120 **perform multiple functions that enable the inventive system to efficiently manage network resources while providing a desired level of quality of service to users**." *DirecTV* at col. 12:42-46 "Note that each application may request or be associated with a number of data cast sessions**. The bandwidth allocated to an application session can change based on several factors,** including: **the QoS requested by the application for that session**; the priority of the session;" *DirecTV* at col. 18:4-9 "**As is evident from the preceding discussions, bandwidth management** (e.g., allocation and reallocation) **is one of the most important functions provided by Broadcast Server** 110. It is because of this management function that multiple applications are able to share the same broadcast resource in an efficient manner. **In this sense, one goal of bandwidth management is to provide the best quality of service to all applications using the shared broadcast resource**." *DirecTV* at col. 24:25-32
1.b receiving a **first response to the request from the source node**, wherein the **source node is the point of origin for the purposes of the guaranteed quality of service flow for data to be communicated** within the guaranteed quality of service flow, the first response **indicating whether the source node has available resources to support the guaranteed quality of service flow**;	**A. US7760641** "The improved admission control and traffic shaping algorithms described herein are similar in that each utilizes the key features of a high availability framework. **For example, one member of the cluster is elected "reservation coordinator." As described in more detail below, any member of the cluster may be elected coordinator.** Should the elected coordinator fail for any reason, a new election is made, a message is sent out to each member to reset their state (via inter-group messaging) and the algorithms begin again. **The elected coordinator acts as a rate dealer. For example, each member must reserve some rate from the coordinator to allow for passing of requests. To accommodate changes in rate distribution, each member of the cluster runs an estimation algorithm (referred to as the "estimator") for**

1.b receiving a **first response to the request from the source node**, wherein the **source node is the point of origin for the purposes of the guaranteed quality of service flow for data to be communicated** within the guaranteed quality of service flow, the first response **indicating whether the source node has available resources to support the guaranteed quality of service flow**;	**executing a real-time rate capacity estimation**." *IBM* at col. 8:41-55 "As noted above, **the "rate limiter bucket" is an algorithm commonly used to implement admission control procedures**. In the prior art algorithm, **a "bucket" is provided with a limit imposed on the rate of messages entering a protected network node**." *IBM* at col. 9:5-9 "To overcome the disadvantages mentioned above, the basic rate limiter algorithm has been expanded to provide hierarchical rate limit enforcement for admission control. **Instead of specifying a global rate limit for the entire cluster, the global rate limit is distributed among cluster members, as desired**. As shown in FIGS. 3-4, rate limits may be distributed in a hierarchical fashion forming a "rate limit tree." In some embodiments, rate limits may be set at the global level, as well as the service and operation levels for each member (1-N) of the cluster, as shown in FIG. 3. One example of services and operations that may be provided by cluster members is the StockQuote service and getQuote( ) operation used in many Web Services; however, other examples exist. **It is noted that different numbers and/or types of levels may be included within the rate limit tree, in other embodiments of the invention. The only requirement imposed on the rate limit tree is that each rate limit imposed on a parent node equals the sum of the limits imposed on its children**. For example, the rate limit assigned to Service 1 should be equivalent to the sum of the limits assigned to Operations 1-N descending from Service 1." *IBM* at col. 9:36-56 "**When verifying if a request can be admitted, the rate limiter bucket tree is traversed along a path extending from the global level to one of the child nodes**. As noted above, the rate limit assigned to each bucket along the path is the sum of its children. In order to admit a request to a child node (e.g., Operation 1), the request must be able to fit within each bucket along the traversed path (e.g., Global->Service 1->Operation 1). **If the request fits within each bucket, the request token(s) are added to each bucket along the path**. If the request token(s) do not fit within each bucket along the path, they are not added and the request is rejected." *IBM* at col. 10:1-11

1.b receiving a **first response to the request from the source node**, wherein the **source node is the point of origin for the purposes of the guaranteed quality of service flow for data to be communicated** within the guaranteed quality of service flow, the first response **indicating whether the source node has available resources to support the guaranteed quality of service flow**;	**B. US20090028141** "An ingress edge router 100 according to the invention comprises a customer interface module 101. **The customer interface module** 101 **handles the transmission of messages to the customer** 180 a **and/or the reception of messages sent by the customer** 180 a **when the latter wants to access a service with guaranteed quality of service. The customer interface module** 101 **receives from the customer** 180 a **a request to access a service with guaranteed quality of service**. This request comprises, among other things, an identifier of the requested service, an identifier of the customer 180 a, **the destination IP address with which the customer** 180 a **wants the service with guaranteed quality of service to be set up**, even a password for authenticating the customer 180 a to the requested service. **The customer interface module** 101 **is able to transfer the content of each request to the admission control module** 102 **of the ingress edge router** 100. The customer interface module 101 is able to transfer to the customer 180 a messages representative of the acceptance or denial of access to the service with guaranteed quality of service." *Orange* at par. 0056 **C. US8711696** "**Application policies** 250 **specify which applications are allowed to use the broadcast network and how they are allowed to use it. This includes defining the total bandwidth available for a group of applications. Additionally, any limitations concerning the bandwidth allocated to a particular application may be defined by these polices. Application policies** 250 **may specify different priorities, bandwidth ranges**, or allocations based on time of day, or on what other applications are currently active, for example." *DirecTV* at col. 18:26-35
1.c receiving **a second response to the request from the at least one egress node indicating whether the at least one egress node has available resources to support the guaranteed quality of service flow**; and	**A. US7760641** "**FIG. 4 illustrates another way in which rate limits may be distributed within a "rate limit tree" and bucket contents may be tracked within a "rate limiter bucket tree." For example, rate limits may be distributed/tracked at a requester level, in addition to the global, service and operation levels described above. As used herein, a "requester" is defined as a client or user requesting access to a particular service or application provided by the cluster**. In some cases, the tree structure shown in FIG. 4 may be used to extend admission control concepts to include

1.c receiving **a second response to the request from the at least one egress node indicating whether the at least one egress node has available resources to support the guaranteed quality of service flow**; and	distributed enforcement of Service Level Agreements (SLAs)." *IBM* at col. 10:25-35 "**The only requirement imposed on the rate limit tree is that each rate limit imposed on a parent node equals the sum of the limits imposed on its children**. For example, the rate limit assigned to Service 1 should be equivalent to the sum of the limits assigned to Operations 1-N descending from Service 1." *IBM* at col. 9:51-55 "**When verifying if a request can be admitted, the rate limiter bucket tree is traversed along a path extending from the global level to one of the child nodes**. As noted above, the rate limit assigned to each bucket along the path is the sum of its children. In order to admit a request to a child node (e.g., Operation 1), the request must be able to fit within each bucket along the traversed path (e.g., Global->Service 1->Operation 1**). If the request fits within each bucket, the request token(s) are added to each bucket along the path.** If the request token(s) do not fit within each bucket along the path, they are not added and the request is rejected." *IBM* at col. 10:1-11 **B. US20090028141** "According to another aspect of the invention, **if a tunnel to carry the data flow or flows linked to the service with guaranteed quality of service can be created between the ingress edge router and the egress edge router in the label-switched telecommunication network, a message is transferred to the customer accepting the request from the customer to set up a service with guaranteed quality of service in the telecommunication network**." *Orange* at par. 0031 "In the next step E301, **a check is carried out as to whether the customer having sent the request is authorized to access the service with guaranteed quality of service. For this, the ingress edge router** 100 a, **to which the customer** 180 a **having sent the request is linked, transfers the access request to the network controller** 160. **The network controller** 160 **interrogates the service provider** 170 **which, in return, authorizes or denies the customer** 180 a **access to the service with guaranteed quality of service**." *Orange* at par. 0068

1.c receiving **a second response to the request from the at least one egress node indicating whether the at least one egress node has available resources to support the guaranteed quality of service flow**; and	**C. US8711696** "Allocated Bandwidth. **The allocated bandwidth is the bandwidth at which an application is currently allowed to operate. It may be one of the thresholds defined above, or any value in between**. If an application is using less than its allocated bandwidth, it can make the difference available to other applications in the system with the assurance that it can ask for it back at a later time." *DirecTV* at col. 10:17-23
1.d if the source node and the at least one egress node have **available resources to support the guaranteed quality of service flow, then allocating resources for the guaranteed quality of service flow**;	**A. US7760641** "A flow chart diagram illustrating one embodiment of an improved admission control algorithm is shown in FIG. 5. When deciding whether or not to admit a client request, the improved admission control algorithm compares a cluster member's current rate consumption (stored locally within a rate limiter bucket tree) with the rate limits specified in that member's rate limit tree (stored within the reservation coordinator). **More specifically, the algorithm traverses a path between the global rate bucket and one of the child node buckets included within the cluster member's rate limiter bucket tree. If there is enough room to add the request token(s) to each bucket along the traversed path, the request is admitted**. Otherwise, the estimator is called to determine whether or not additional rate capacity can be reserved to satisfy the client request. **Additional rate capacity may be awarded to the requesting member if sufficient rate is available in the cluster tree**." *IBM* at col. 12:8-24 **B. US20090028141** "**When the processing rules to be observed for the requested service have been obtained, the admission control module** 102 **is able to order the tunnel agent** 107 **of the ingress edge router** 100 **to set up a connection that is able to support the service requested by the customer** 180. **The tunnel agent** 107 **selects an existing tunnel between the ingress and egress edge routers or creates, based on processing rules comprising the traffic engineering parameters linked to the requested service, a new connection between the ingress and egress edge routers**." *Orange* at par. 0060 **C. US8711696** "Allocated Bandwidth. The allocated bandwidth is the bandwidth at which an application is currently allowed to operate. It may be one of the thresholds defined above, or any

1.d if the source node and the at least one egress node have **available resources to support the guaranteed quality of service flow, then allocating resources for the guaranteed quality of service flow**;	value in between. **If an application is using less than its allocated bandwidth, it can make the difference available to other applications in the system with the assurance that it can ask for it back at a later time**. An application can not use more than its allocated bandwidth, but it can ask for more if needed. **If the bandwidth is available, it will be allocated to the application under the condition that it may be taken away later**. The allocated bandwidth is dynamic, and can change over time based on other applications' activity." *DirecTV* at col. 10:17-23
1.e if the source node and the at least one egress node **do not have available resources to support the guaranteed quality of service flow, then:** 1.f **denying the guaranteed quality of service flow**; and	**A. US7760641** "**If there is not room within each bucket to admit the request**, the estimator is called to determine whether additional rate capacity can be reserved to ultimately satisfy the request (step 525). FIG. 6 illustrates one manner in which the estimator may be used to determine the additional reservation amount. Other methods for determining the additional reservation amount are possible and should be considered to fall within the ordinary scope of the invention." *IBM* at col. 12:62-67 through col. 13:1-2 "When verifying if a request can be admitted, the rate limiter bucket tree is traversed along a path extending from the global level to one of the child nodes. As noted above, the rate limit assigned to each bucket along the path is the sum of its children. In order to admit a request to a child node (e.g., Operation 1), the request must be able to fit within each bucket along the traversed path (e.g., Global->Service 1->Operation 1). If the request fits within each bucket, the request token(s) are added to each bucket along the path. **If the request token(s) do not fit within each bucket along the path, they are not added and the request is rejected.**" *IBM* at col. 10:1-11 "As shown in FIG. 6, the estimator may begin by calculating the amount of elapsed time between the current time and the beginning of the last silence period (step 600). **As used herein, the "silence period" may be defined as a predetermined time period after a reservation rejection in which subsequent reservation requests are suppressed. The "silence period" begins once a reservation request (i.e., a request for additional rate capacity) is rejected**. The silence period is used to avoid overloading the reservation coordinator with repeated reservation requests and rejects. **In other words,**

1.e if the source node and the at least one egress node **do not have available resources to support the guaranteed quality of service flow, then:** 1.f **denying the guaranteed quality of service flow**; and	**the estimator implements suppression of request rates to keep the members from sending additional reservation requests when there is no possibility of reserving more rate**. Without suppression, message chunking would also cease to work." *IBM* at col. 13:3-16 **B. US20090028141** "**The admission control module** 102 **is able to control the generation of a message denying access to the service requested by the customer** 180 **if the controller** 160 **of the MPLS network has responded negatively to the request**." *Orange* at par. 0059 "In the next step E302, **the ingress edge router** 100 **checks whether the customer is authorized or denied access. If not, in the step** E303, **a denial message is transmitted via the customer interface** 101 **to the customer** 180 **having sent the request**. If the check is positive, the algorithm goes on to the next step E304." *Orange* at par. 0069 **C. US8711696** "2. **Based on the expected bandwidth required**, other sessions that this application may have open, and the application policy as set by the operator, **determine if the new request would cause the session constraints for the application to be violated (in accordance with the Session Bandwidth Constraints discussed previously):** a. Sum the expected bandwidths for all sessions with the same priority as the new request, the expected bandwidth requested by the new session, and all guaranteed minimum bandwidths for all sessions with a priority lower than the new request; b. **If the sum above is greater than the expected bandwidth as set by the operator in the application's policy, deny the request and**:" *DirecTV* at col. 29:33-46
1.g **if the guaranteed quality of service flow is denied based on bandwidth-related reasons, then determining a maximum data rate that would have resulted in a successful request for a guaranteed quality of service flow, and transmitting**	**A. US7760641** "In some cases, **the reservation coordinator maintains a rate limit tree for the entire cluster** (referred to as a "cluster tree"), **and a separate rate limit tree for each member of the cluster** (referred to as "member trees"). The cluster tree is used for tracking rate limits and consumption across all members of the cluster. Member trees are used for comparing a particular member's allocated rate limits against the cluster limits. For

a message comprising information describing the maximum data rate that would have resulted in a successful request for a guaranteed quality of service flow.	example, **the rate limits specified for each node of a member tree will correspond to some share of the rate limits specified in the cluster tree. Member consumption is tracked within the local rate limiter bucket trees stored within each cluster member**." *IBM* at col. 11:23-33 "As described in more detail below, the traffic shaping algorithm differs from the admission control algorithm in: i) when the estimator is called and ii) when to release capacity. For example, the estimation algorithm described below should be called for every single request, regardless of whether the request is admitted or rejected. This is due to the fact that token buckets actively regenerate burst, therefore it is desirable to regenerate burst as quickly as possible by consuming tokens at each and every request. **Likewise, capacity should only be released once a bucket has reached its maximum rate limit, thereby providing maximum local burst capability and indicating that the rate is truly excessive**. The improved traffic shaping algorithm, according to one embodiment of the invention, is illustrated in FIGS. 9-11." *IBM* at col. 17:5-18 "If the reservation chunk amount is greater than zero (in step 925), the cluster member may send a reservation request to the reservation coordinator to ask for more rate (step 930). The reservation request may be granted if there is enough rate capacity within the cluster to satisfy the reservation request. **For example, the reservation coordinator may compare the current rate consumption of all cluster members (stored within the local token buckets) to the maximum average sustained rate for the entire cluster. If the additional rate capacity asked for by the cluster member causes the combined reservation capacity of all members to exceed the maximum average sustained rate, the reservation coordinator rejects the reservation request and returns a reservation amount of zero**." *IBM* at col. 19:11-24 **B. US20090028141** "The applicable rules are, for example, **and in a non-limiting way, the maximum bit rate allowed for all the services requested by the customer** 180 a **and/or the maximum number of sessions authorized for the customer** 180 a. When the rules and parameters have been obtained, the algorithm goes on to the next step E305 which consists in transferring the latter to the tunnel agent module 107." *Orange* at par. 0070

1.g **if the guaranteed quality of service flow is denied based on bandwidth-related reasons, then determining a maximum data rate that would have resulted in a successful request for a guaranteed quality of service flow, and transmitting a message comprising information describing the maximum data rate that would have resulted in a successful request for a guaranteed quality of service flow.**	"7. The method as claimed in claim 6, wherein, the **rules applicable to the customer comprise at least one of the elements of the group containing the maximum bit rate authorized for all the services requested by the customer and the maximum number of sessions authorized for the customer**." *Orange* at claim 7 **C. US8711696** "2. **Based on the expected bandwidth required**, other sessions that this application may have open, and the application policy as set by the operator, **determine if the new request would cause the session constraints for the application to be violated (in accordance with the Session Bandwidth Constraints discussed previously)**: a. **Sum the expected bandwidths for all sessions with the same priority as the new request, the expected bandwidth requested by the new session, and all guaranteed minimum bandwidths for all sessions with a priority lower than the new request**; b. If the sum above is greater than the expected bandwidth as set by the operator in the application's policy, deny the request and: i. **compute the expected bandwidth that could be allocated as the difference between expected bandwidth defined in the application's policy and the sum computed above, minus this new request**; ii. **based on the bandwidth computed above, compute an expected quality of service that could be given relative to the original quality of service requested and return that value to the application**;" *DirecTV* at col. 29:33-54