

An online charging method and system based on user's traffic

TECHNOLOGY FIELD

The present invention relates to the filed of the online charging of Business Operation Support System, particularly to an online charging method and system based on user's traffic.

BACKGROUND OF THE INVENTION

With the development of the network confusion and the maturation of the operation-providing technology, the new service and value-added service constantly emerge, resulting in the urgent requirement of building the Business Operation Support System capable of supporting the multiple services for the Operator, wherein the service charging is the one of central functions, and the online charging system (OCS) capable of supporting multiple services real-time charging is the key to realize the multiple service operation and minimize s loss of the operator's income.

3rd Generation Partnership Project (3GPP) defines two types of payment modes and two types of charging modes. The payment modes are classified into the prepaid billing including the real-time prepaid billing and hot billing, and postpaid billing with respect to the relationship between the time for which the user uses the service and the time for charging. And, the charging modes are classified into online charging and offline charging with respect to the management of the account in real time or not. Both of the post-payment and the hot billing belong to the offline charging which is a kind of charging manner of pre-using the service and post charging, that is, the charging system doesn't involve during using service, performs the post-charging based on the service usage record following to the service usage. The offline charging mode is advanced to the capability of providing the complex tariff plan and flexible preferential strategy, but has the shortcomings as follow:

(1) ineffectively controlling the risk of the bad debt resulting from the owing for the

service in bad faith from the user with the lower credit, and “final service usage”, which causes the great economic losses to the operator each year;

(2) the user can't make inquiries about its balance in real time to obtain consuming details at any time; and

(3) the balance can be computed only after the user's service usage is completed and the list in details is provided, lacking for the function of terminating the service during the user's usage, resulting in ineffectively supporting the service with high risk and service line, and limiting the kinds of service supported by the charging system.

Real-time pre-payment is a kind of online charging which utilizes the charging mechanism that the charging information is capable of affecting the user's service usage, and requires the capability of the charging system to interact with the service control network element in real time to realizing real-time service control. The conventional online charging is implemented mostly through two distinct approaches, the IN-based approach, i.e. intelligent network- based approach, and the approach based on inverse calculation of service units. The IN-based approach, realized by a Service Control Point (SCP) of IN-based prepaid system in most implementations of domestic operators, has the disadvantages of only supporting the limited range of services since the implementation of the charging system depends on the network architecture, and the incapability of supporting the customized tariff plans and discounting policies, as well as the flexible tariff packaging and service bundling.

The approach based on inverse calculation of service units can be classified into the direct approach calculating the amount available to the service based on the inverse function of the tariff plans and the balance of the account, with the disadvantage of the limited range of application resulting from that it's impossible to obtain the inverse function for each price function in view of the flexible tariff plans and various discounting policies provided by the operator; and the indirect approach which searches the price function in virtue of the tentative calculation through Probe method, and indirectly obtains the amount available to the service with bisection method according to the tariff plans and the balance of the account, with the disadvantages of the low charging efficiency resulting from the requirement of performing the inverse calculation from the balance to the amount

available to the service for many times during online charging; and the difficulty of allocating the balance for the online charging system when charging the multiple payment of the service from one account.

In summary, it's really required an online charging method overcoming the above disadvantages with the increase in the kinds of the service and improvement on the requirement of the real-time charging of the service from the operator.

SUMMARY OF THE INVENTION

One object of the present invention is to provide an online charging method and system based on user's traffic, which pre-allocates the amount available to the service based on the history of user's traffic through the usage times slide window technology, so as to realize the online charging function. The method of the present invention may decrease the inverse computation times from the amount of the money to the amount available to the service during online charging, and improves the charging efficiency, so as not only enabling to allocate the initial amount available to the service as possible as satisfying the user's usage habit, but also decrease the anticipant interacting times between a service control network element and the online charging system during the online charging to a constant, resulting in the decrease on the complicated pressure of the online charging system. And, according to the method according to the present invention, the amount available to the subsequent service of the current session is computed through the index backoff algorithm with the threshold to reduce the complexity of the computation; and in case that the balance of the account is not enough to pay the pre-assigned initial amount available to the service, the priority is computed according to the usage of the system resource of the each service of the service system and followed by reallocating the balance of all the services with the priority lower than that of the current requested service in order, so as to improve the utilization rate of the idle service resources and ensure the maximization of the operator's rights and interests.

In order to achieve the above object, the technical solution as follows is applied to the

online charging method and system based on user's traffic of the present invention.

The online charging system based on user's traffic, including a charging control module for realizing the online charging control based on the session, the incident or the service bearing the charging types; and a rating management module, for converting the traffic into the charging amount of service according to the customized tariff plans, discounting policies, traffic, and the related time information so as to realize the rating function, is characterized of additionally comprising of

a session management module, for managing the session information of the said the online charging system, providing the judgment on the repetitiveness of the session, saving the information of the amount available to the service allocated to each session, monitoring the session, and dealing with the overtime session or the failure session;

a traffic management module, for managing the information of the history of the traffic for user's each service, maintaining the statistic information, allocating the amount available to the service, and realizing the management on the reallocation of the reserve, wherein the said statistic information refers to the statistical measure of the previous traffic of the user's service in the usage times slide window or in total, in the form of the average, the quantile or the statistics of the traffic; and

a balance management module for managing the balance information of the user's account, and dealing with the recharging and query in real-time, so as to realize the management on the reservation of the balance in the account.

In addition, the said online charging system of the present invention exteriorly interacts with a service control network element, a service network administrator, a management system of the user's data, and a database system, so as to control the user's traffic through the interaction with the said service control network element, obtain the usage of the system resource of the each service in the system through the interaction with the said service network administrator, know the user's tariff plans and recharging amount through the interaction with the said a management system of user's data, and record and save the session information and the details through the interaction with said database system.

The service control network element receives the service request carrying a user identity

and terminal parameters from the end user, followed by sending an online charging request to the online charging system which asks the traffic management module to pre-allocate an initial amount available to the service according to the user's previous traffic of such service in the usage times slide window with a prescribed size, upon receiving it, followed by calling the rating management module to rate the initial amount available the service so as to obtain the initial amount. In case of the balance of the account less than the initial amount, the online charging system calculates the service priority according to the usage of the system resource of the each service in the service system from the service network administrator, followed by re-allocating the balance of those service with the priority lower than that of the user's currently requested service in order, wherein inversely calculating the balance into the initial amount available to the service through the bisection method in case that the new balance following to the re-allocation is still less than the initial amount. And, the online charging system reserves the initial amount in the user's account, followed by releasing the initial amount available to the service to the service control network element which releases the service flow to the user and controls the user's traffic by applying for user the new amount available to the service which is calculated for pre-allocation according to the amount available to the service last assigned to the user in this session through the index backoff algorithm with a threshold by the online charging system, in case that the initial amount available to the service is exhausting and the user doesn't terminate the usage of the service, so that the initial amount available to the service following to the reservation is released to the service control network element, and the user's service is completed, in the meanwhile the service control network element reporting the details of user's present usage of the service to the online charging system which rates, releases the reserve and save the current traffic of this service so that the online charging process is completed.

The online charging method based on user's traffic according to the present invention includes the steps as follow,

- 1) an end user initiates a service usage request carrying a user identity and terminal parameters;
- 2) a service control network element extracts the parameters including a user identity, terminal parameters, and service parameters with response to the above request, followed

- by initiating an online charging request to an online charging system;
- 3) the said online charging system acquires the parameters of the charging request, followed by calling a traffic management module to calculate an initial amount U_0 available to the service ;
 - 4) the said online charging system calls a rating management module to calculate a service charge M corresponding to the initial amount U_0 according to the user's tariff plans;
 - 5) if the balance C_r of the account is more than or equal to the service charge M , which is enough to pay the service charge, the step 8) is performed;
 - 6) if the balance C_r of the account is less than the service charge M , and C_r is less than or equal to δ , the threshold value of the account balance predetermined by the system, the online charging system rejects the current service request, and sets the available amount into zero, followed by performing the step 8);
 - 7) if the balance C_r of the account is less than the service charge M , and C_r is more than δ , a charging control module obtains the set S of the user's service in use, $S = \{S_0, S_1, \dots, S_j\}$, from a session management module, asks the network administrator for the usage of the system resource of the each service in the service system and calculates the service priority listing P , $P = \{P_j, P_0, P_1, \dots, P_i\}$, for the currently requesting service S_j and the other service of the set S followed by re-allocating the reserve of the user's service with the priority lower than P_j in use, until that the balance of the account satisfies the service charge or all of the services have been completed, and subsequently updating the initial amount available to the service and the service charge following the re-allocation;
 - 8) the charging control module of the said online charging system saves the amount available to the service into the session management module by the session identity, and reserves the sum, followed by releasing the amount available to the service to a service control network element;
 - 9) the said service control network element receives the amount available to the service and regulates the user's service usage by performing the step 12) in the case that the user terminates the service usage prior to the decrease of the remaining amount available to the service to less than the predetermined threshold value U_t , otherwise performing the subsequent step 10), wherein the said predetermined threshold value U_t is calculated based on the netdelay, the online charging processing time and the rate of the traffic

consumption;

10) the new amount available to the service is applied for the user by the said service control network element in case that the user doesn't terminate the service usage when the remaining amount available to the service is less than the predetermined threshold value U_i , so that the charging control module calculates the amount U_i available to the service for the pre-allocation, $U_i = \max\{U_{last} * \theta, U_{min}\}$, according to the amount U_{last} available to the service last assigned to the user with respect to the session identity from the session management module by the index backoff algorithm with the threshold assuming U_{min} as the threshold which is the pre-determined minimum amount available to the service according to the service characters by the system, and θ as the pre-determined backoff index ranged from 0 to 1 ;

11) following to obtaining the currently assigned amount U_i available to the service by the step 10), the online charging system calls the rating management module to rate the amount U_i available to the service according to the user's tariff plans, and calculates the corresponding service charge M , followed by performing the step 5);

12) in case that the user terminates the service usage prior to its remaining amount available to the service less than the predetermined threshold value U_i , the user's current service is completed, and the said service control network element reports the particulars of the user's current service usage to the said online charging system; and

13) the said online charging system rates according to the abovementioned user's tariff plans and the particulars of the service usage, followed releasing the reserved balance, storing the information of traffic for the current service, and iteratively updating the statistical information of the previous traffic of user's such service in the usage times slide window, until the ending of the current online charging process.

In addition, according to one aspect of the method of the present invention, in the said step 3), the traffic with the super-long history is topped, and the initial amount available to the service is allocated according to the statistic value of the previous traffic of the user's service by the method as follows,

31) the traffic management module calls the session management module to determine the property of the present session and request a session identity;

32) the session management module deals with the said session according to the

parameters of the request by allocating the new session identity to a new session, followed by performing the step 33), or querying the session identity corresponding to a previous session, followed by performing the said step 10) to assign the present session the new amount available to the service;

33) in case of the previous usage times of the user's such service less than the threshold *Count* with a range of 10 to 20 set by the system, the initial amount U_0 available to the service is assumed as $U_0 = U_{min}$, referring U_{min} as the initial value of the traffic pre-determined by the system ;

34) the previous traffic of the user's such service ranks as $U_0, U_1, \dots, U_{k-1}$ in the order of the time, followed by recording all the super-long traffic with $U_i > U_{max}$, and setting $U_i = U_{max}$; wherein U_{max} is the upper limit of the traffic pre-determined according to the service character by the system;

35) computing the average of the traffic for the recent *Size* times according the size of the slide window, by assuming $E(U) = \sum_{i=k-Size}^{k-1} U_i / Size$ in case of $k \geq Size$, otherwise assuming $E(U) = \sum_{i=0}^{k-1} U_i / k$, wherein *Size* is the size of the slide window which is predetermined by the system and ranged from 20 to 40 with respect to the various services; and

36) pre-allocating the user the initial amount U_0 available to the service, $U_0 = f(E(U))$, wherein *f* is the function taking $E(U)$ as the independent variable.

Furthermore, according to the another aspect of the online charging method of the present invention, in the said step 7), in case that the balance of the account is insufficient to pay the initial amount available to the service, allocating the service priority according to the usage of the system resource of the each service in the service system, followed by re-allocating the balance of all the service with the lower priority in use, until the balance of the account satisfies the service charge or all the services are completed, which additionally comprises of the steps as follow,

71) in case that the service set *S* is empty or the set *S* doesn't contain the service with the priority lower than P_j , taking the initial amount U_0 available to the service as the initial maximum value, the minimum traffic U_{min} determined by the system as the initial minimal value respectively, and " $U_0 - U_{min} < U_{min}$ ", or " $M + \delta > C_r$ " as the condition of terminating the iteration wherein " $U_0 - U_{min} < U_{min}$ " is the difference for the iteration traffic,

followed by converting the balance C_r of the account into the amount U available to the service and the corresponding service charge M through the bisection method and updating them, followed by performing the step 8);

72) selecting the service S_m with the minimum priority from the S set, in the meanwhile the online charging system interacts with its service control network element to acquire the previous traffic U_u of the user's such service, wherein in case of U_u more than or equal to the γ -fold of the statistic value of the previous traffic of the user's such service in the usage times slide window, i.e. $U_u \geq U_e * \gamma$, removing S_m from the set S , followed by returning to perform the step 71), wherein γ depends on the relationship between the parameter predetermined by the system and the service priority, ranged from 0 to 1;

73) in case of U_u less than the γ -fold of the statistic value of the previous traffic of the user's such service in the usage times slide window, i.e. $U_u < U_{new} = U_e * \gamma$, redistributing the amount of the money, assigning the total traffic U_{new} to the service S_m under control of its service control network element, calling the rating management module to obtain the corresponding amount, releasing the reserved remaining amount, updating the information of the traffic of this session in the session management through its identity, and removing S_m from the set S , and

74) increasing the balance C_r of the account resulting from redistributing, followed by performing the step 8) in case of $C_r \geq M$, otherwise returning to the 71).

Furthermore, according to the still another aspect of the online charging method of the present invention, in the said step 10), allocation of the subsequent amount available to the service is computed by the index backoff algorithm with the threshold, which further includes the steps as follow:

101) rating the amount U_1 available to the service to obtain the service charge M , followed by performing the step 11) in case of M less than or equal to the balance C_r of the account;

102) rejecting the current service request in case of $C_r \leq \delta$, and setting the amount available to the service into zero, followed by performing the step 11);

103) in case of the service charge M more than the balance C_r of the account, and $U_1 = U_{min}$, rejecting the current service request and setting the amount available to the service into zero, followed by performing the step 11); and

104) in case of the service charge M more than the balance C_r of the account, and $U_1 > U_{\min}$, updating the amount available to the service in the way of $U_1 \leftarrow \max\{U_1 * \theta, U_{\min}\}$, and rating the service charge corresponding to the updating, followed by performing the step 102).

Accordingly, the online charging method and system based on user's traffic of the present invention pre-allocates the amount available to the service according to the history of the traffic of the user's service in the slide window with the prescribed-size, performs the process of rating and reserves the corresponding balance in the account, followed by releasing the amount available to the service control network element, which pre-allocate the initial amount available to the service according to the history of the traffic of the user's service in the slide window.

The online charging method and system based on user's traffic of the present invention allocate the traffic with the incremental method by continuing to apply to assign the additional traffic which is computed by multiplying the last assigned one by the backoff index and limiting the lower limit with the threshold by the index backoff algorithm with the threshold, so as to avoid the inverse computation from the balance of the account to the amount available to the service, in case that the initial amount available to the service doesn't satisfy the requirement of the user's current service request.

According to the online charging method and system based on user's traffic of the present invention, in case that the balance of the account is not enough to pay the initial amount available to the service, the online charging system ranks the priority of the service according to the usage information of the service resource of the each service of the system, followed by re-allocating the balance of the service with the lower priority.

The online charging method and system based on user's traffic disclosed by the present invention realize the online charging function by pre-allocating the amount available to the service based on the previous traffic of the user's service with the usage times slide window technology. In particular, the service control network element initiates the online charging request with response to the user's service request to the online charging system

which pre-allocates the initial amount available to the service according to the previous traffic of the user's such service in the usage times slide window by computing the subsequent amount available to the service by the index backoff algorithm with the threshold in case of insufficient initial amount to the current service, followed by calculating the priority according the usage of the system resource of the each service of the system, in case that the balance of the user's account is not enough to pay the charge of initial amount available to the service, and re-allocating the balance of all the service in use with the priority less than that of the currently requesting service, followed by inversely computing the balance of the account into the amount available to the service with the bisection method in case of insufficient balance of the account following to the re-allocation to pay the initial traffic. Therefore, the method of the present invention has the characters of

- 1) reducing the inverse computing times from the charge to the amount available to the service during online charging, resulting in the improvement on the charging efficiency;
- 2) not only distributing the initial amount available to the service as possible as to satisfy the user's usage habit, but also decreasing the expected interaction times between the service control network element and the online charging system to a constant, resulting in reducing the complicated pressure of the online charging system;
- 3) computing the subsequent amount available to the current service by the index backoff algorithm with the threshold, resulting in decreasing the computation complexity; and
- 4) in case of insufficient balance of the account to pay the pre-allocated initial amount available to the service, computing the priority of the service according to the usage of the system resource of the each service of the system, followed by re-allocating the balance of the service with the lower priority, so as to improve the utilization rate of the idle service resource and ensure the operator's interests in maximum.

In summary, the online charging method based on the user's traffic of the present invention is advanced in

- 1, allocating the initial amount available to the service based on the history of traffic of the service which is requested for charging by the user, so as to allocate the amount available to the service to satisfy the usage of the user's current service with the probability more than 50%, resulting in decreasing the expected interaction times between the service

control network element and the online charging system;

2, in case of insufficient balance of the account to pay the initial amount available to the service, re-allocating the reserved amount of the account according to the usage of the system resource of the each service of the system, so as to improve the utilization rate of the idle service resource; and

3, computing the subsequent amount available to the service by the index backoff algorithm with the threshold, in case of insufficient initial amount available to the service to meet to the requirement, so as to reduce the complexity for computation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the architecture of the online charging system base on the user's traffic of the present invention.

FIG. 2 illustrates the interactive graphics of the online charging process for the online charging method based on the traffic of the present invention.

FIG. 3 is a follow chart of the online charging method based on the traffic of the present invention.

FIG. 4 is a graph showing probability distribution function according to the online charging method based on the user's traffic in one example.

DESCRIPTION OF THE PREFERRED IMPLEMENTATION

Illustrating the online charging method and system based on the user's traffic taking the average of the previous traffic as the statistical value of the previous traffic of the user's service in the usage times slide window in details hereinafter, with reference to the drawings.

FIG. 1 illustrates the architecture of the online charging system base on the user's traffic of the present invention. As shown in FIG. 1, the online charging system comprises:
a charging control module for realizing the online charging control based on the session, the incident or the service bearing the charging types;

a session management module, for managing the session information of the said the online charging system, providing the judgment on the repetitiveness of the session, saving the information of the amount available to the service assigned to the each session, monitoring the session, and dealing with the overtime session or the failure session;

a traffic management module, for managing the information of the history of the traffic of user's each service, maintaining the statistic information, allocating the amount available to the service, and realizing the management on reallocating the reserved amount, wherein the said statistic information refers to the statistical measure of the previous traffic of the user's service in the usage times slide window or in total, in the form of the average, the quantile or the statistics of the traffic;

a balance management module for managing the balance information of the user's account, and dealing with the recharging and query in real-time, so as to realize the management on the reservation of the balance in the account; and

a rating management module, for converting the traffic into the charging amount of service according to the customized tariff plans, discounting policies, traffic, and the related time information, so as to realize the rating function.

In addition, the said online charging system of the present invention exteriorly interacts with a service control network element, a service network administrator, a management system of user's data, and a database system, so as to control the user's traffic through the interaction with the said service control network element, know the usage of the system resource of the each service of the system, acquire the user's tariff plans and recharging amount through the interaction with the said a management system of user's data, and record and save the session information and the details through the interaction with said database system. The protocols for interaction of the online charging system with the exterior system comprise Diameter credit control protocol for the interaction with the service control network element, Transmission Control Protocol for the interaction with the database system, and the real-time interface for the interaction with the service network administrator and the management system of user's data, so as to meet to the requirement of the real-time.

FIG. 2 is the interactive graphics of the online charging process for the online charging

method based on the traffic of the present invention, indicating each device for the online charging and the process. As shown in FIG. 2, the service control network element receives the service request carrying a user identity and a terminal parameter from the end user, followed by initiating a online charging request to the online charging system which pre-allocates the initial amount available to the service according to the average of the previous traffic of the user's such service in the usage times slide window. In case of insufficient balance of the account to pay the initial amount available to the service, the online charging system calculates the service priority according to the usage of the system resource of the each service in the service system from the service network administrator, followed by re-allocating the amount of all the service with the priority lower than that of the user's current requested service in order. The online charging system requests the total previous traffic from the service control network element of this service, and the new total traffic is the γ -fold of the average of the previous traffic of the user's such service in the usage times slide window, wherein γ depends on the relationship of the predetermined parameter by the system and the service priority, ranged from 0 to 1. In case that the balance of the account following to the re-allocation is not enough to pay the initial amount available to the service, the balance of the account is inversely computed into the initial amount available to the service through the bisection method. In case that the allocated amount available to the service doesn't meet to the requirement of the user's current service, the service network element initiates the subsequent service request, and the online charging system computes the currently allocated amount available to the service through the index backoff algorithm with the threshold according to the last allocated traffic, followed by reporting the particulars of the service to the online charging system following to the completion of the user's service, releasing the remaining reserved amount, and iteratively updating the average of the previous traffic of the user's such service in the usage times slide window, so that the online charging process is completed.

FIG. 3 is a follow chart of the online charging method based on the traffic of the present invention. As shown in FIG. 3, the online charging method based on user's traffic according to the present invention comprises the steps as follow,

- 1) an end user initiates a service usage request carrying a user identity and terminal parameters;

- 2) a service control network element extracts the parameters including a user identity, terminal parameters, and service parameters with response to the above request, followed by initiating an online charging request to an online charging system;
- 3) the said online charging system acquires the parameters of the charging request, followed by calling a traffic management module to calculate an initial amount U_0 available to the service, wherein
in the said step 3), the traffic with the super-long history is topped, and the initial amount available to the service is allocated according to the statistic value of the user's previous traffic by the method as follows,
 - 31) the traffic management module calls the session management module to determine the property of the present session and request a session identity;
 - 32) the session management module deals with the said session according to the parameters of the request by allocating the new session identity to a new session, followed by performing the step 33), or querying the session identity corresponding to a previous session, followed by performing the said step 11) to assign the new amount available to the service to the present session;
 - 33) in case of the previous usage times of the user's such service less than the threshold *Count* ranged from 10 to 20 with respect to the various service and set by the system, the initial amount U_0 available to the service is assumed as $U_0 = U_{init}$, assuming U_{init} as the initial value of the traffic pre-determined by the system ;
 - 34) the previous traffic of the user's such service ranks as $U_0, U_1 \dots U_{k-1}$ in the order of time, followed by recording all of the super-long traffic with $U_i > U_{max}$, and setting $U_i = U_{max}$, wherein U_{max} is the upper limit of the traffic pre-determined by the system according to the service character;
 - 35) computing the average of the traffic for the recent *Size* times, wherein *Size* is the size of the slide window which is predetermined by the system and ranged from 20 to 40 with respect to the various services, by assuming $E(U) = \sum_{i=k-Size}^{k-1} U_i / Size$ in case of $k \geq Size$, otherwise assuming $E(U) = \sum_{i=0}^{k-1} U_i / k$; and
 - 36) pre-allocating the user the initial amount U_0 available to the service, $U_0 = f(E(U))$, wherein f is the function taking $E(U)$ as the independent variable;
- 4) the said online charging system calls a rating management module to calculate a service

charge M corresponding to the initial amount U_0 available to the service according to the user's tariff plans;

5) if the balance C_r of the account is more than or equal to the service charge M , which is enough to pay the service charge, performing the step 8)

6) if the balance C_r of the account is less than the service charge M , and C_r is less than or equal to δ , the threshold of the account balance predetermined by the system, the online charging system rejects the current service request, and sets the amount available to the service into zero, followed by performing the step 8);

7) if the balance of the account C_r is less than the service charge M , and C_r is more than δ , a charging control module obtains the set S of the user's current service, $S = \{S_0, S_1, \dots, S_j\}$ from a session management module, asks the network administrator for the usage of the system resource of the each service in the service system and calculates the service priority listing P , $P = \{P_j, P_0, P_1, \dots, P_i\}$, for the currently requesting service S_j and the other services of the set S followed by re-allocating the reserved sum of the user's service with the priority lower than P_j currently in use until that the balance of the account satisfies the service charge or all of the services have been completed,

wherein in the said step 7), in case that the balance of the account is insufficient to pay the initial amount available to the service, allocating the service priority according to the usage of the system resource of the each service in the service system, followed by re-allocating the balance of all the service with the lower priority in use, until the balance of the account satisfies the service charge or all of the services are completed, which additionally includes the steps as follow,

71) in case that the service set S is empty or the set S doesn't contain any service with the priority lower than P_j , taking the initial amount U_0 available to the service as the initial maximum value, the minimum traffic $U_{\min}$ determined by the system as the initial minimal value respectively, and " $U_0 - U_{\min} < U_{\min}$ ", or " $M + \delta > C_r$ " as the condition of terminating the iteration wherein " $U_0 - U_{\min} < U_{\min}$ " is the difference for the iteration traffic, followed by converting the balance C_r of the account into the amount U available to the service and the corresponding service charge M through the bisection method and updating them, and followed by performing the step 8);

72) selecting the service S_m with the minimum priority from the S set, in the meanwhile the online charging system interacts with its service control network element to acquire

the previous traffic U_u of the user's such service, wherein in case of U_u more than or equal to the γ -fold of the statistic value of the previous traffic of the user's such service in the usage times slide window, i.e. $U_u \geq U_e * \gamma$, removing S_m from the set S , followed by returning to perform the step 71), wherein γ depends on the relationship between the parameter predetermined by the system and the service priority, and is ranged from 0 to 1;

73) in case of U_u less than the γ -fold of the statistic value of the previous traffic of the user's such service in the usage times slide window, i.e. $U_u < U_{new} = U_e * \gamma$, re-allocating the amount of the money, assigning the total traffic U_{new} to the service S_m , calling the rating management module to obtain the corresponding amount, releasing the reserved remaining balance, updating the information of the traffic of this session in the session management through its identity, and removing S_m from the set S ; and

74) increasing the balance C_r of the account resulting from redistributing, followed by performing the step 8) in case of $C_r \geq M$, otherwise returning to the step 71);

8) the charging control module of the said online charging system saves the amount available to the service into the session management module by the session identity, and reserves the sum, followed by releasing the amount available to the service to a service control network element;

9) the said service control network element receives the amount available to the service and regulates the user's service usage by performing the step 12) in the case that the user terminates the service usage prior to the decrease of the remaining amount available to the service to less than the predetermined threshold value U_l , otherwise performing the subsequent step 10), wherein the said predetermined threshold value U_l is calculated based on the netdelay, the online charging processing time and the rate of the traffic consumption;

10) the new amount available to the service is applied for the user by the said service control network element in case that the user doesn't terminate the service usage when the remaining amount available to the service is less than the predetermined threshold value U_l , so that the charging control module obtains the traffic U_{last} last assigned to the user with respect to the session identity from the session management module, followed by calculating the current pre-allocated amount U_l available to the service, $U_l = \max\{U_{last} * \theta, U_{min}\}$, by the index backoff algorithm with the threshold assuming

$U_{\min}$ as the threshold which is the pre-determined minimum amount available to the service according to the service characters, and θ as the pre-determined backoff index ranged from 0 to 1, wherein

in the said step 10), allocation of the subsequent traffic available to the service is computed by the index backoff algorithm with the threshold, which further includes the steps as follow:

101) rating the amount U_1 available to the service to obtain the service charge M , followed by performing the step 11) in case of M less than or equal to the balance C_r of the account;

102) rejecting the current service request, and setting the amount available to the service into zero, followed by performing the step 11), in case of $C_r \leq \delta$;

103) in case of the service charge M more than the balance C_r of the account, and $U_1 = U_{\min}$, rejecting the current service request and setting the traffic into zero, followed by performing the step 11); and

104) in case of the service charge M more than the balance C_r of the account, and $U_1 > U_{\min}$, updating the amount available to the service in the way of $U_1 \leftarrow \max\{U_1 * \theta, U_{\min}\}$, and rating the service charge M corresponding to the updating it, followed by performing the step 102);

11) following to obtaining the currently assigned amount U_i available to the service by the step 10), the online charging system calls the rating management module to rate the amount U_i according to the user's tariff plans, and calculates the corresponding service charge M , followed by performing the step 5);

12) in case that the user terminates the usage of the service prior to its remaining amount available to the service less than the predetermined threshold value U_r , the user's current service is completed, and the said service control network element reports the particulars of the user's current service to the said online charging system; and

13) the said online charging system rates according to the user's tariff plans and the particulars of the service usage, followed releasing the reserved balance, storing the information of traffic for the current service, and iteratively updating the statistical information of the previous traffic of user's such service in the usage times slide window, so that the current online charging process is completed.

In addition, according to the online charging method of the present invention, in the said step 3), the initial amount available to the service may be pre-allocated according to the average of the previous traffic of the user's such service in the usage times slide window, which is computed and iterated as follow,

331) assuming the average of the previous traffic as $E(U) = U_{init}$ in case of the previous usage times k of the user's such service satisfying $k < Count$, wherein U_{init} is the initial value of the traffic predetermined by the system, and $Count$ is the threshold value ranged from 10 to 20, and predetermined by the system;

332) ranking the previous traffic of the user's such service into $U_0, U_1 \dots U_{k-1}$ in the order of the time, followed by recording all the super-long traffic satisfying $U_i > U_{max}$ and assuming $U_i = U_{max}$, wherein U_{max} is the upper limit of the traffic pre-determined by the system;

333) computing by the formula $E(U) = \sum_{i=0}^{k-1} U_i / k$, and iterating by the formula $E'(U) = (E(U) * k + U_k) / (k+1)$ in the case of the previous usage times k of the user's such service satisfying $Count \leq k < Size$;

334) in the case of the previous usage times k of the user's such service satisfying $k \geq Size$, computing by the formula $E(U) = \sum_{i=k-Size}^{k-1} U_i / Size$, finding out the user's recent service usage habit based on the user's recent service traffic, and approaching to the original formula through the iteration formula $E'(U) = (1 - \alpha) * E(U) + \alpha * U_k$ under the introduction of the forgetting factor α , $\alpha = 2^{-1/Size}$, resulting in the formula (1) as below indicating that the previous traffic with the loner history contributes less to $E(U)$,

$$E(U)_n = (1 - \alpha)^{Size-1} E(U)_{n-Size+1} + \sum_{i=n-Size+3}^n (1 - \alpha)^{n-i} * \alpha * U_i \quad (\text{wherein } n \geq Size, \alpha = 2^{-1/Size})$$

$$= (1 - \alpha)^{Size-1} E(U)_{n-Size+1} + (1 - \alpha)^{Size-2} * \alpha * U_{n-Size+2} \dots + \alpha * U_n \quad \dots (1)$$

FIG. 4 is a graph showing probability distribution function according to the online charging method based on the user's traffic in one example. As shown in FIG. 4 setting the step length of the traffic into 6 sec, and the upper limit of the traffic into 900 sec, the probability distribution of the previous traffic of the user's such service for 800 times within the 3 months is obtained by statistics. And, the computed average of the previous traffic of the user's such service is about 125.8 sec through the method of the present

invention. It's distinctly indicated by the probability distribution graph that the initial traffic of 125.8 sec which is pre-allocated to the user's such service may satisfy the user's current request in the probability about 70%.

In summary, the present invention provides a online charging method and system which pre-allocates the amount available to the service according the statistical value of the previous traffic of the user's such service in the usage times slide window, wherein allocating the amount available to the service through the increment method comprising of the computation of the initial amount available to the service according to the statistical value of the previous traffic of the user's such service in the usage times slide window, and the computation of the subsequent traffic according to the last assigned amount available to the service in the current session through the index backoff algorithm; calculating the priority of the service according to the usage of the system resource of each service in the system, followed by re-allocating the amount of the money for all the service in use with the priority less than that of the currently requested service, so as to improve the utilization rate of the idle service resource in case of insufficient balance in the account to pay the initial traffic available to the service.

In addition, for the above implementation, the online charging system and method based on the user's traffic also may pre-allocate the initial traffic available to the service according to the statistical value of all the previous traffic of the user's such service, allocate the initial amount available to the service according to the statistical value of all the previous traffic of the user's such service, and compute the initial amount available to the service according to the statistical value of the traffic in the form of the average, quantile or statistics etc.

While the embodiments of the various aspects of the present invention that have been described are the preferred implementation, those skilled in the art will understand that variation thereof may also be possible. The system and method described therein are applicable to the other system of the service statistics and management field. Therefore, the invention is entitled to protection within the full scope of the appended claims.

Claims

PCT/CN2009/001450

WHAT IS CLAIMED IS:

1. An online charging system based on user's traffic, including a charging control module for realizing the online control based on the session, the incident or the service bearing the charging types; and a rating management module, for converting the traffic into the charge according to the customized tariff plans, the discounting policies, the traffic, and the related time information so as to realize the rating function, is characterized of additionally comprising

a session management module, for managing the session information of the said the online charging system, providing the judgment on the repetitiveness of the session, saving the information of the amount available to the service allocated to each session, monitoring the session, and dealing with the overtime session or the failure session;

a traffic management module, for managing the information of the history of the traffic for user's each service, maintaining the statistic information, allocating the amount available to the service, and realizing the management on reallocating the reserve, wherein the said statistic information refers to the statistical value of the previous traffic of the user's service in the usage times slide window or in total, in the form of the average, the quantile or the statistics of traffic; and

a balance management module for managing the balance information of the user's account, and dealing with the recharging and query in real-time, so as to realize the management on the reservation of the balance in the account.

2. The online charging system based on user's traffic according to the claim 1, is characterized in that the said traffic management module allocates the initial amount to the service based on the previous traffic of the charging request service initiated by the user, and if the initial amount available to the service can't meet to the demand of the user's current service, the subsequent amount available to the service is calculated through the index backoff algorithm with the threshold.

3. The online charging system based on user's traffic according to the claim 1, is characterized in that the said balance management module allocates the service priority

according to the usage of the system resource of each service of the service system, followed by reallocating the reserve of the account with respect to the relationship of the service priority in case of insufficient balance of the account to pay the initial amount available to the service.

4. An online charging method based on user's traffic, is characterized of including the steps as follow,

- 1) an end user initiates a service usage request carrying a user identity and terminal parameters;
- 2) a service control network element extracts the parameters including a user identity, terminal parameters, and service parameters with response to the above request, followed by initiating an online charging request to an online charging system;
- 3) the said online charging system acquires the parameters of the charging request, followed by calling a traffic management module to calculate an initial amount U_0 available to the service ;
- 4) the said online charging system calls a rating management module to calculate a service charge M corresponding to the initial amount U_0 according to the user's tariff plans;
- 5) if the balance C_r of the account is more than or equal to the service charge M , which is enough to pay the service charge, the step 8) is performed;
- 6) if the balance C_r of the account is less than the service charge M , and C_r is less than or equal to δ , the threshold value of the balance in the account predetermined by the system, the online charging system rejects the current service request, setting the amount available to the service into zero, followed by performing the step 8);
- 7) if the balance C_r of the account is less than the service charge M , and C_r is more than δ , a charging control module obtains the set S of the user's current service in use, $S = \{S_0, S_1, \dots, S_i\}$, from a session management module, asks the network administrator for the usage of the system resource of the each service in the service system and calculates the service priority listing P , $P = \{P_j, P_0, P_1, \dots, P_i\}$, for the currently requesting service S_j and the other service of the set S followed by re-allocating the reserve of all the user's service in use with the priority lower than P_j , until that the balance of the account satisfies the service charge or all of the services have been completed, and subsequently updating the initial amount available to the service and the service charge;

- 8) the charging control module of the said online charging system saves the amount available to the service into the session management module by the session identity, and reserves the sum of the amount, followed by releasing the amount available to the service to a service control network element;
- 9) the said service control network element receives the amount available to the service and regulates the user's service usage by performing the step 12) in the case that the user terminates the service usage prior to the decrease of the remaining amount available to the service to less than the predetermined threshold value U_i , otherwise performing the subsequent step 10), wherein the said predetermined threshold value U_i is calculated based on the netdelay, the online charging processing time and the rate of the traffic consumption;
- 10) the new amount available to the service is applied for the user by the said service control network element in case that the user doesn't terminate the service usage when the remaining amount available to the service is less than the predetermined threshold value U_i , so that the charging control module obtains the traffic U_{last} last assigned to the user with respect to the session identity from the session management module, followed by calculating the current pre-allocated amount U_i available to the service, $U_i = \max\{U_{last} * \theta, U_{min}\}$, by the index backoff algorithm with the threshold assuming U_{min} as the threshold which is the pre-determined minimum amount available to the service according to the service characters, and θ as the pre-determined backoff index ranged from 0 to 1;
- 11) following to obtaining the currently assigned traffic U_i by the step 10), the online charging system calls the rating management module to rate the amount U_i available to the service according to the user's tariff plans, and calculates the corresponding service charge M_i followed by performing the step 5);
- 12) in case that the user terminates the usage of the service prior to the decrease of the remaining amount available to the service to less than the predetermined threshold value U_i , the user's current service usage is completed, and the said service control network element reports the particulars of the user's current service to the said online charging system; and
- 13) the said online charging system rates according to the abovementioned user's tariff plans and the particulars of the service usage, followed releasing the reserved remaining

balance, saving the information of traffic for the current service, and iteratively updating the statistical information of the previous traffic of user's such service in the usage times slide window, until the ending of the current online charging process.

5. The online charging method based on user's service quantity according to the claim 4, is characterized in that in the said step 3), the traffic with the super-long history is topped, and the initial amount available to the service is allocated according to the statistic value of the user's history of the traffic by the method as follows,

31) the traffic management module calls the session management module to determine the property of the present session and request a session identity;

32) the session management module deals with the said session according to the parameters of the request by allocating the new session identity to a new session, followed by performing the step 33), or querying the session identity corresponding to a previous session, followed by performing the said step 10) to assign the new amount available to the service to the present session;

33) in case of the previous usage times of the user's such service less than the threshold *Count* with a range of 10 to 20 set by the system, the initial amount U_0 available to the service is assumed as $U_0 = U_{init}$, assuming U_{init} as the initial value of the traffic pre-determined by the system;

34) the previous traffic of the user's such service ranks as $U_0, U_1 \dots U_{k-1}$ in the order of time, followed by recording all of the super-long traffic with $U_i > U_{max}$, and setting $U_i = U_{max}$, wherein U_{max} is the upper limit of the traffic pre-determined according to the service character by the system;

35) computing the average of the traffic for the recent *Size* times with respect to the size of the slide window by assuming $E(U) = \sum_{k=Size}^{k-1} U_i / Size$ in case of $k \geq Size$, otherwise assuming $E(U) = \sum_0^{k-1} U_i / k$, wherein *Size* is the size of the slide window which is predetermined by the system and ranged from 20 to 40 with respect to the various services; and

36) pre-allocating the user the initial amount U_0 available to the service, $U_0 = f(E(U))$, wherein *f* is the function taking $E(U)$ as the independent variable.

6. The online charging method based on user's traffic according to the claim 4, is

characterized of, in the said step 3), accounting the initial amount available to the service according to the statistic value of the user's previous traffic of the user's such service in the usage times slide window or in all, which the average of the previous traffic of the user's such service in the usage times slide window is accounted and iterated as follow,

331) assuming the average $E(U)$ of the previous traffic as $E(U) = U_{init}$ in case of the previous usage times k of the user's such service satisfying $k < Count$, wherein U_{init} is the initial value of the traffic predetermined by the system, and $Count$ is the threshold value ranged from 10 to 20, set by the system;

332) ranking the previous traffic of the user's such service into $U_0, U_1 \dots U_{k-1}$ in the order of time, followed by recording all of the super-long traffic and assuming $U_i > U_{max}$, wherein U_{max} is the upper limit of the traffic pre-determined by the system;

333) computing by the formula $E(U) = \sum_{i=0}^{k-1} U_i / k$, and iterating by the formula $E(U) = (E(U) * k + U_k) / (k + 1)$ in the case of the previous usage times k of the user's such service satisfying $Count \leq k < Size$;

334) in the case of the previous usage times k of the user's such service satisfying $k \geq Size$, computing by the formula $E(U) = \sum_{i=k-Size}^{k-1} U_i / Size$, finding out the user's service usage habit based on the user's recent traffic, and approaching to the original formula with the iteration formula $E(U) = (1 - \alpha) * E(U) + \alpha * U_k$ under the introduction of the forgetting factor α , $\alpha = 2^{-1/Size}$, resulting in the formula (1) as below,

$$E(U)_n = (1 - \alpha)^{Size-1} E(U)_{n-Size+1} + \sum_{i=n-Size+3}^n (1 - \alpha)^{n-i} * \alpha * U_i \quad (\text{wherein } n \geq Size, \alpha = 2^{-1/Size})$$

$$= (1 - \alpha)^{Size-1} E(U)_{n-Size+1} + (1 - \alpha)^{Size-2} * \alpha * U_{n-Size+2} \dots + \alpha * U_n \quad \dots (1).$$

7. The online charging method based on user's traffic according to the claim 4, is characterized of, in the said step 7), in case that the balance of the account is insufficient to pay the initial amount available to the service, allocating the service priority according to the usage of the system resource of each service of the service system, and re-allocating the balance of all the user's service in use with the lower priority, until the balance of the account satisfies the service charge or all of the services are completed, which comprises the steps as follow,

71) in case that the service set S is empty or S doesn't include the service with the priority lower than P_j , taking the initial amount U_0 available to the service as the initial

maximum value, and the minimum traffic $U_{\min}$ set by the system as the initial minimal value respectively, and $U'_0 - U'_{\min} < U_{\min}$, wherein $U'_0 - U'_{\min}$ is the difference between the iteration traffic, or $M + \delta > C_r$, as the iteration ending condition, followed by converting the balance C_r of the account into the amount U available to the service and the corresponding service charge M with the bisection method, updating and performing the step 8);

72) selecting the service S_m with the minimum priority from the S set, in the meanwhile the online charging system interacts with its service control network element to acquire the previous traffic U_u of the user's such service, wherein in case of U_u more than or equal to the γ -fold of the statistic value of the previous traffic of the user's such service in the usage times slide window, i.e. $U_u \geq U_e * \gamma$, γ depending on the relationship of the predetermined parameter by the system and the service priority, ranged from 0 to 1, removing S_m from the set S , followed by returning to perform the step 71);

73) in case of U_u less than the γ -fold of the statistic value of the previous traffic of the user's such service in the usage times slide window, i.e. $U_u < U_{new} = U_e * \gamma$, redistributing the balance to assign the total traffic U_{new} to the service S_m , calling the rating management module to obtain the corresponding amount, releasing the reserved remaining amount, updating the information of the traffic of this session in the session management with respect to the session identity, releasing the new total traffic U_{new} to the service control network element of the service S_m , and removing S_m from the set S , and

74) performing the step 8) in case of $C_r \geq M$, otherwise returning to the 71), following to increase the balance C_r of the account by allocation.

8. The online charging method based on user's traffic according to the claim 4, is characterized of, in the said step 10), allocation of the subsequent amount available to the service is computed by the index backoff algorithm with the threshold, which further includes the steps as follow:

101) rating the amount U_1 available to the service to obtain the service charge M , followed by performing the step 11) in case of M less than or equal to the balance C_r of the account;

102) rejecting the current service request in case of $C_r \leq \delta$, and setting the amount

available to the service into zero, followed by performing the step 11);

103) in case of the service charge M more than the balance C_r of the account and $U_1 = U_{\min}$, rejecting the current service request, and setting the amount available to the service into zero, followed by performing the step 11),

or in case of the service charge M more than the balance C_r of the account and $U_1 > U_{\min}$, updating the amount available to the service in the way of $U_1 \leftarrow \max\{U_1 * \theta, U_{\min}\}$, and rating the service charge corresponding to the updating, followed by performing the step 102).