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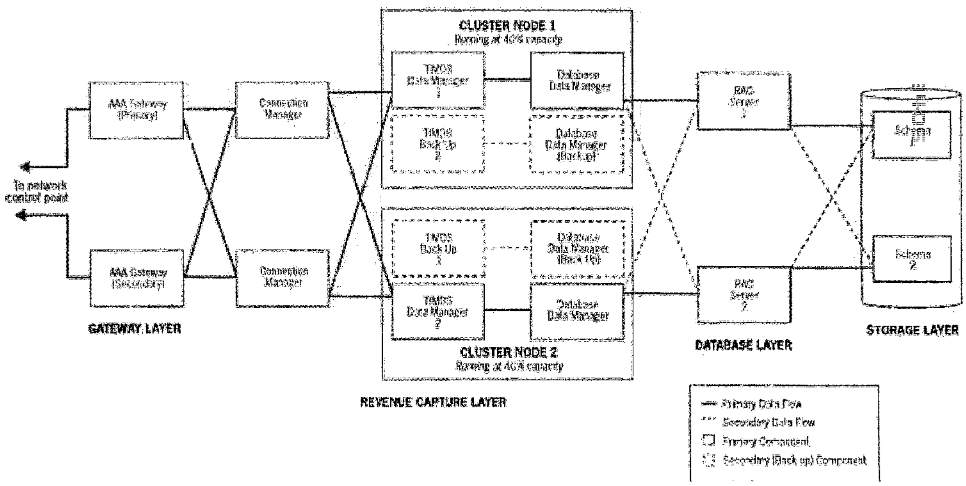

(57) **Abstract:** A revenue management system and method for telecommunication network use is disclosed. The revenue management system can be integrated with the internet protocol multimedia subsystem (IMS). The revenue management system and method can have a hardware and/or software revenue generation module or architecture, revenue capture module or architecture, revenue collection module or architecture, revenue analysis module or architecture, or combinations thereof.

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TITLE OF THE INVENTION

REVENUE MANAGEMENT SYSTEM AND METHOD

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CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Provisional Application No. 60/694,743, filed 28 June 2005, and 60/694,743, filed 28 July 2005 which are hereby incorporated by reference in their entireties.

BACKGROUND OF THE INVENTION

[0002] Telecommunication network operators and service providers are currently implementing the internet protocol multimedia subsystem (IMS). IMS is a set of Internet Protocol (IP) standards for session-based control of multimedia and telephony services on any network type, including circuit switched networks, packet-switched networks, and the public switched telephone network (PSTN). IMS manages the communication, collaboration, and entertainment media over internet protocol. IMS enables users to access both content and other users in ways that are natural and intuitive.

[0003] IMS provides users with functionality that is not dependent on fixed or mobile networks and also retains existing protocols, including the session initiation protocol (SIP). The SIP is central to IMS. Originally developed for voice over Internet Protocol (VoIP), SIP enables multiple users to enter and exit at will an ongoing communications session (i.e. a connection between two or more communications terminals such as a mobile handset a content server, or a personal computer). Moreover, SIP enables users to add or remove media (voice, video, content, etc.) dynamically during a session and run multiple sessions in parallel.

[0004] IMS enabled services will include combinations of push-to-talk, click-to-dial, multi-player gaming, video telephony, SMS, dynamic push content, including file sharing, and video conferencing, and location-based commerce among other communication, collaboration, and entertainment services.

[0005] These services previously existed in independent silos: that is, users must exit one service (i.e., terminate a session) before they can access a new service (i.e., initiate a session). The routing, network location, addressing, and session management of IMS eliminates the walls of the silos to effect a so-called blended functionality that lets users move freely between networks and services while maintaining multiple concurrent sessions. In this way, IMS transforms a sequence of discrete communication events into a single shared communications environment.

[0006] For example, users will be able to select a communications mode (voice, voice with video, text-to-speech email, and so on) that best suits their circumstances while retaining the freedom to change that selection dynamically by adding a video stream midway through a voice call for example. Users will also be able to access familiar services on any device and via any network type, fixed or mobile. And they'll enjoy these freedoms along with new functionalities such as broader payment options, credit control presence management, and convenient connectivity to groups.

[0007] IMS also provides operators and service providers opportunities for cost reductions and revenue growth. They can expect cost reductions because IMS enabled services, unlike today's siloed services, do not require replication of every functionality: charging, routing, provisioning, and subscriber management, for example. Rather, IMS services can reuse the same functionality across all services, thereby accruing for their operators significant savings in capital and operational expenditures. Revenue growth through enabling enhanced services is IMS's other benefit. In this way, IMS is the panacea-in-waiting to communications and media companies, who face the threat of commoditization.

[0008] Telecommunication network Operators and service providers will need a convergent charging system to realize the value of IMS. Such a system - with its integrated view of the customer - is necessary to apply cross-service discounts on bundled offerings and other marketing promotions, as well as a single consolidated bill for each customer - even when services originate from multiple third-party providers.

[0009] Legacy billing applications have become increasingly inadequate to the demands of charging for IMS-enabled services as charging has undergone a profound transformation in recent years: from batch to real-time processing, from a back-office support function to a front-office mission-critical function, from a cost to be minimized to a strategic opportunity for revenue maximization.

[0010] Further, operators know that consumers have choices. In this environment, CSP's have difficulty remaining competitive if unable to maintain an uptime of at least 99.999% - so-called "five-nines" availability. Five-nines, which amounts to barely five minutes of downtime per year, is unprecedented in traditional billing.

[0011] As batch-processing systems, traditional billing vendors did not have to provide highly-available solutions. If the billing system failed during a batch run, the job could simply be restarted once the system became available. For this reason CSPs were forced to maintain separate systems to handle their prepaid and postpaid subscribers and services. Prepaid voice services were generally managed by the network equipment vendors, who traditionally provided prepaid solutions in the form of a service control point (SCP) or service node. These systems - built with the network in mind, especially prepaid voice – were designed to achieve the high-availability and low latency requirements of tier-1 service providers. However, this design focus, together with support for only very simple rating capabilities, resulted in these systems being much more restrictive than their postpaid counterparts.

[0012] Because no single system provided support for all the revenue management functions, CSPs have often had to deploy dozens of separate systems to support those functions. Different "stovepipe" systems managed prepaid and postpaid services, while still other systems managed services such as voice, data, content, and messaging. Such a multifarious environment has driven operational costs higher and hampered CSPs' ability to meet increasingly aggressive market requirements.

[0013] CSPs can no longer afford the operational excess of maintaining multiple systems: instead CSPs need a simple, convergent, and modular revenue management solution that delivers high performance and high availability as well as flexibility and scalability. The revenue management system must also meet the demands of consumer marketing-a complex function that increasingly entails bundled offerings, conditional multiservice discounts, highly segmented promotions, and revenue sharing across a multipartner value chain of content providers, service providers, and network operators.

[0014] Unlike telecommunications networks, which must route their transport (calls in circuit-switched networks and packets in packet-switched networks) in real time, legacy billing systems for telecommunications providers have customarily fulfilled a back-office function, batch processing records such as call detail records and IP detail records. If a billing system weren't available when scheduled to process a particular batch, engineers could fix the problem, then run the process a few hours behind schedule. In the worst-case scenario, customers' bills would arrive in their mail boxes a day or two later than usual. But new expectations of communications service users are now changing the rules of the billing game.

[0015] Today's users demand diverse payment options in line with their varied personal, business, and family needs.

[0016] Whereas some will continue to favor long-standing relationships in which they settle their accounts with operators in the traditional manner of postpayment via invoice, more and more users now require the freedom to prepay – perhaps by purchasing a prepaid card at a grocery store as credit towards service from potentially multiple CSPs over a period of time. Still other users want to pay for products and services as they consume them-so-called now-pay - by providing a debit- or credit-card number at the commencement of each transaction.

[0017] In the absence of a convergent real-time solution, CSPs have had to address the bang needs of their prepaid, postpaid, and now-pay customers by maintaining multiple, non-integrated billing and customer-care systems. Indeed, they've had no alternative because legacy billing systems were never designed to accommodate the transactional real-time requirements for prepay and now-pay services. And they certainly weren't built with the requisite low latency and five-nines availability that a revenue management system needs to process as many as several hundred million transactions per day in real time via a direct connection to the telecommunications network.

[0018] The absence of a billing system that could meet the high performance/low-latency and high-availability requirements for prepaid has imposed significant costs on CSPs since they were forced to maintain multiple separate systems for their prepaid/postpaid environments and services.

BRIEF SUMMARY OF THE INVENTION

[0019] A revenue management system and method for revenue management are disclosed. The revenue management system can be a network of computers, a single computer, a program on computer readable medium, software and/or hardware architecture, or combinations thereof. The revenue management system can be used, for example by telecommunication network operators and service providers, to manage the use of and revenue generated by telecommunications networks. The telecommunications networks can be wired and/or wireless.

[0020] The revenue management system can perform convergent real-time charging for prepaid, postpaid, and now-pay telecommunication network user accounts. The revenue management system can manage revenues through the entire service cycle, from revenue generation to revenue capture to revenue collection to revenue analysis. The revenue management system can have a hardware and/or software revenue generation module or architecture, revenue capture module or architecture, revenue collection module or architecture, revenue analysis module or architecture, or combinations thereof. (Any elements or characteristics denoted or described as being modules, architectures, layers, or platforms, herein, can be any of the other of modules, architectures, layers or platforms.)

[0021] The revenue generation module or architecture can minimize delays of deployment of new-services on the telecommunication network. The revenue generation module or architecture can have GUI-based applications for rapidly provisioning, pricing, discounting, and managing all aspects of customer and partner relationships such as personalized promotions and revenue sharing.

[0022] The revenue capture module or architecture can leverages a high-performance and high-availability platform that converts all transactions into revenue with zero leakage from fraud or system downtime. The high availability platform further minimizes customer churn.

[0023] The revenue collection module or architecture can ensure accurate bills for postpaid accounts while collecting all prepaid and now-pay revenue in real-time. The revenue collection module can generate partner (e.g., business partner) statements and provide a real-time view of finances, for example, to suggest changes in marketing strategy.

[0024] The revenue analysis module or architecture can process the transactions that pass through the revenue management system and can provide data for predetermined mathematical functions (i.e., data analysis). The revenue analysis module can be used with IMS-enabled services.

[0025] The revenue management system can provide carrier-grade performance, high availability, unlimited scalability, flexibility to rapidly launch and manage IMS-enabled services, perform end-to-end revenue management, and combinations thereof.

[0026] The revenue management system can be a single convergent platform for service providers to manage revenue in real time across customer type, network, service, payment method and geography. The revenue management system can have high-performance, high-availability, and scalability, for example equal to that of a front-end carrier-grade network element, with the functionality and flexibility of a convergent revenue management system.

[0027] The revenue management system can be a unified system that manages revenue in real time across any customer type (residential or business), network type (packet- or circuit-switched), service type (voice, data, commerce, and so on), payment method (prepaid, postpaid, and now-pay), and geography (multiple currencies and tax regimens). After examining the implications of inadequate performance and availability in CSPs' billing and customer-care platforms. The revenue management system can have a revenue capture platform and an in-memory object store (e.g., TIMOS or other technology) for high performance/low latency and an active/active staged architecture for high availability.

[0028] The revenue management system can deliver carrier-grade performance, unlimited scalability, five-nines availability, the flexibility to rapidly launch and manage new services, and combinations thereof.

[0029] The revenue management system can give operators a unified view of their subscribers (e.g., rapid and organized viewing of database information for users across various networks). The revenue management system can be configured to analyze database data for market segmentation, to create discounts (e.g., multiservice discounts), and promote and deliver functionality, such as consolidation of all services onto a single bill.

[0030] The revenue management system can accurately manage multiple revenue touch points with end-customers, for example, to enable networks to provide and bill a variety of voice and multimedia services.

[0031] The convergent revenue management system can eliminating duplication and exploiting economies of scope, it can thus incur lower operational costs than multiple non- integrated systems. Such efficiencies can translate into substantial savings in resources, skills, training, hardware, etc. The convergent revenue management system can have greater flexibility and scalability than multiple stand-alone systems. The system can provide an integrated view of the customer with important functionality benefits such as the ability to apply cross-service discounts to bundled offerings and the capacity to generate a single bill for each customer, even when services originate from multiple providers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] Figure 1 illustrates a variation of the revenue management system integrated into the IMS framework.

[0033] Figure 2 illustrates a variation of the revenue management system with a network layer.

[0034] Figure 3 illustrate a variation of the revenue management system.

[0035] Figure 4 illustrates a variation of the revenue management system with exemplary load distributions.

[0036] Figure 5 illustrates a variation of the revenue management system having multi-database subsystems.

[0037] Figure 6 illustrates the set-up for benchmark testing of the revenue management system.

DETAILED DESCRIPTION

[0038] Figure 1 illustrates that the revenue management system can be integrated (i.e., in data communication with) the IMS framework. Users can access IP-based services via any device and any access network through a standardized access point, the CSCF (call session control function) or SIP server. The CSCF sets up and manages sessions, forwarding messages and content from other users or from content and application servers. The CSCF works in partnership with the HSS (home subscriber service), which manages subscriber data and preferences, enabling users to find one another and access subscribed services. A CGF (charging gateway function) can mediate access to other operators' networks and support application for charging, provisioning, and customer service.

[0039] Figure 2 illustrates that the architecture of the revenue management system can have a gateway layer (e.g., a AAA Gateway), a revenue capture layer, and a database and storage layer. The gateway layer can connect to the external network via a service platform such as HP OpenCall (from Hewlett Packard, Inc., Palo Alto, CA) , which in turn can connects to a network switch.

[0040] The gateway layer can be an interface to the network layer. Connections to the network layer can be maintained via one, two or more AAA (authentication, authorization, accounting) Gateway managers. The AAA Gateway managers, which can include one primary and one or more idle-but-running back up, connect to the network SCP via TCP/IP, and manage a number of tasks. The tasks can include protocol translation, asynchronous interface, load balancing, service-level agreement (SLA) latency enforcement, failure detection, failure handling, failure recovery, and combinations thereof.

[0041] The protocol translation can provide high-speed translation from the protocol used by the network SCP to a communication protocol (e.g., Portal Communications Protocol (PCP)). The AAA Gateway can support the HP OpenCall's Message Based Interface (MBI) protocol, Diameter Charging, and PCP. The AAA Gateway can provide extension to support additional protocols.

[0042] In asynchronous connection to the SCP, requests can be received from the SCP and acknowledged. Following completion of the requested operation, the asynchronous interface of the AAA Gateway can send a response to the SCP with the final results.

[0043] The load balancing element can distribute requests evenly across the available Connection Managers using a round-robin algorithm.

[0044] The SLA enforcement can monitor and guarantee conformance to a service-level agreement's latency requirements.

[0045] The failure detection element can detect failures such as a broken link between a AAA Gateway and a connection manager in the revenue capture platform.

[0046] The failure handling element can provide an interim request storage facility for requests processed during back-end failures and pending recovery, and a degraded mode of operation for cases in which the back end is not available or simply not responding within the specified latency levels.

[0047] The failure recovery element can replay requests into the revenue capture platform following a failure.

[0048] When the call (or other connection) comes to the network, the SCP can query the AAA Gateway in order to grant the service (i.e. authorize the call). During the call the SCP keeps the revenue management system appraised of the call status by passing call-start and call-end requests-as well as Reauthorizing requests if the previously authorized quantity is close to exhaustion.

[0049] The AAA Gateway can convert the SCP requests into event data records (EDR). The AAA Gateway can then forward the EDR to a specialized processing pipeline-authentication, authorization, or accounting, for example, depending on the service and request type. The processing pipelines can contain a module that can call an API of the CM in the Revenue Capture Platform. This is a synchronous call that blocks processing until receipt of a response. The response can then undergo translation into the EDR, and the EDR can pass to the network output module, which can send the response back to the SCP.

[0050] This process can be monitored for latency by a timeout monitoring facility in the AAA Gateway. If the timeout facility detects an unacceptable latency, the timeout facility can pass the EDR to a timeout pipeline. The timeout pipeline can then execute business logic to handle the request in a degraded mode in order to ensure a response with required latency levels. The degraded mode can allow the timeout pipeline to make a decision on how to proceed based on a configurable set of rules. For example, if the request is for authorization of a local call, the rules might indicate approval by default following the timeout of such a request. A timed-out request for authorization of an international call, in contrast, might receive a default denial.

[0051] Two other pipelines - the exception pipeline and the replay pipeline - can lean up, store, and replay timed-out requests to prevent any revenue leakage. If a timeout was caused by a failure in the Revenue Capture Platform, the replay pipeline can read the replay log after the Revenue Capture Platform is back online and send it the logged requests. If a timeout happened for other reasons, the replay can start immediately.

[0052] The revenue capture layer can implement the authentication and authorization that is necessary for prepaid and now-pay transactions. The revenue capture layer can handle the accounting tasks of event rating and recording all transactions. Figure 3 illustrates that the revenue capture layer can have one, two or more Connection Managers, Database Data Managers, and TIMOS (transactional in-memory object store) Data Managers, a high-performance in-memory store that can synchronize with the database. The elements of the revenue capture layer can be encompassed by the Revenue Capture Platform.

[0053] Each AAA Gateway manager can connect to one, two or more distinct connection managers via TCP/IP. As opposed to the primary/backup model, these two connections are always in use during normal processing. Initial requests to the CAIs are distributed evenly by a simple round-robin algorithm. Cross-machine distribution of the connections can provide fault-tolerance at the hardware level. (The number of Connection Managers could be determined by the operator's availability and scalability requirements).

[0054] The Connection Managers can rout requests to the appropriate TIMOS Data Manager or back-end Database Manager. The design of the revenue management system can provide time-sensitive requests such as authentication and authorization to be performed by accessing data from the high-speed in-memory TIMOS cache only. Accounting requests, which can tolerate higher latencies, can access both the TIMOS cache and the back-end database.

[0055] The system can be configured so non-real-time requests bypass the TIMOS Data. Non-real-time requests can include, for example, batch rating or billing jobs, or real-time requests that do not require millisecond-level response times, such as an account query by a customer service representative.

[0056] Figure 4 illustrates a variation of the revenue management system with exemplary load distributions shown. The architecture of the system can have one, two or more TIMOS instances and their back-up counterparts. Each TIMOS instance can have three components: a reference object cache, a data migratory, and a transient object store.

[0057] The reference object cache can be a cache area for database objects such as customer account records, required for read-only reference during real-time authentication and authorization processes.

[0058] The data migratory can be a subsystem to fill the reference object cache from the database.

[0059] The transient object store can be an area used to store temporary objects for TIMOS-only use such as active-session objects and resource-reservation objects.

[0060] The TIMOS instances can serve distinct sets of the subscriber base. For example, approximately 50% of subscribers per instance for the minimal two-instance configuration shown in Figure 4. Each primary TIMOS instance can run on an independent server with that same server running the back-up instance of another primary TIMOS instance.

[0061] Meanwhile, the Connection Managers can consult a directory server in order to route requests to the correct instance. The directory server can be configurable as a separate process or as a part of any TIMOS instance.

[0062] The TIMOS Data Managers in turn can connect to at least two Database Data Managers, both of which are active and can take over the workload of the other in the case of a failure. The Database Data Managers interface with the back-end relational database.

[0063] The database and storage layers can have one or more server clusters, cluster software, one or more storage area networks, and combinations thereof. The server cluster can be a configuration of at least two database servers, which process data for a single database. The cluster software can manage prepaid payment accounts (e.g., Oracle RAC (Real Application Cluster) cluster software or to execute with the same). The storage area network can support high-speed and high-availability disk storage.

[0064] The revenue management system can access a high-performance relational database such as Oracle RAC via a high-speed storage-area network. The system can utilize multithreading and TIMOS data management. TIMOS can access system memory (i.e. RAM). Requests for data in RAM can be processed much faster than requests for data in the disk-based database. Throughput and latency can be reduced compared to the relational database because of the following differences between TIMOS data management and the RDBMS:

[0065] TIMOS can store in-memory data and avoid the time delays of database access and the translation between a relational representation and the database's physical format.

[0066] The revenue management system employs internal search and storage algorithms that have been optimized for in-memory data, further reducing latencies.

[0067] Read-only requests for TIMOS-managed data can avoid round trips to the back-end database and subsequent disk storage, thereby avoiding multiple network hops and their associated latencies. The creation and update of transient objects can be performed entirely in memory by TIMOS, requiring no disk access operations.

[0068] The system can have a distribution of operations via a staged-availability architecture, an active/active redundancy configuration, and controllable system renewal.

[0069] The revenue management system can have staged-availability architecture that allow higher layers with very high availabilities to maintain system operation—in a degraded mode if necessary—in the event of a failure in a lower-layer component within the Revenue Capture Platform. For example, the Gateway layer can maintain service authorization availability if the primary AAA Gateway loses connectivity to its Connection Manager in the revenue capture layer. Even when operating in a degraded mode, the system can prevent revenue leakage by ensuring that all events are captured in a replay log and persisted to disk for durability. Use of the replay log can ensure that each event undergoes charging as soon as the system recovers.

[0070]

Table 1—Layer Availability and Recovery

Layer	Percentage Availability
Network'	99.999%
Gateway	99.999%
Revenue Capture	99.95%
Database & Storage'	99.999%

[0071]

[0072] Table 1 illustrates the exemplary percentages for each of the revenue management system's layers. Because the AAA Gateway is designed to provide 99.999% availability for service authorization and is able to run in a degraded mode, service availability is significantly higher than the availability of the least-available component. The front-office (e.g., RAM) real-time processing can enable the high availability.

[0073] The system can have an active/active redundancy or an active/passive redundancy. The active/active redundancy can detect failures in components substantially immediately and automatically switch the load of the failed component and to its counterpart. The counterpart can assume the additional load of a failed component because the system can be configured (e.g., appropriately scaled) so nodes run sufficiently below capacity under normal operation and can therefore absorb an additional load during failover.

[0074] The AAA Gateways can divide traffic 50/50 between two active Connection Managers. Each connection manager can route the requests to the appropriate TIMOS Data Manager or Database Data Manager. Each cluster node can run at 40% capacity during normal operation. If one of the TIMOS Data Managers fail to respond to the Connection Managers, the system can automatically failover to a back-up instance of a TIMOS Data Manager that runs on the other cluster node.

[0075] Upon failover, the data migrator can begin to load the backup TIMOS cache with any reference data that had not been preloaded. Processing on the backup system can resume immediately after failover (e.g., the system need not to wait for completion of the data migration). If a request comes in to the back-up TIMOS DM for which the needed data has not yet been loaded into the TIMOS cache, the request can be passed on to the appropriate database DM. The timeout monitor can ensure that the response is made within the required latency limits, although the latency will be higher than for requests to a filled cache. In addition, the requested object can be cached as a side effect for a request to an un-cached object, for example, making subsequent requests for the same data much faster.

[0076] The system can support other types of failover. For example, if the connection between the AAA Gateway and a Connection Manager fails, the Connection Manager whose connection remains operable can assume the full load. Meanwhile, the AAA Gateway can automatically execute custom business logic if it does not receive a response from a Connection Manger within a specified latency. For example, if a Connection Manager failed to respond to a database-update request, the business logic can ensure that the AAA Gateway saves the request for subsequent processing once the system had recovered. Custom business logic can maintain operation—albeit in a degraded mode—under severe failure conditions that deny access to customer balance information.

[0077] High Availability at the database and storage layer can be supported by a combination of a Storage Area Network, a Cluster Server, and Oracle's RAC software. Figure 4 illustrates a database configuration which can have at least two independent servers (e.g., RAC servers), for example *serving distinct customer segments*, located in different database schemas. Each RAC server can dedicated to one database schema. During normal operation, the traffic for both halves of the system can follow different paths and not interfere with each other. In a failure situation, Oracle can redirect the traffic to the remaining RAC server. Oracle RAC can ensure a smooth transition of the traffic to the remaining node.

[0078] Other optional approaches such as storage arrays and disk mirroring can provide additional resilience in the database and storage layers.

[0079] The revenue management system can have a controllable system renewal module, for example to further supplement the high availability. The controllable system renewal can be configured to cause the CSP to limit the lifetime of all system processes, with processes set to restart automatically at designated intervals. Controllable system renewal (i.e., similar to a scheduled failover) can censure that any cumulative errors that might otherwise endanger system stability cannot become critical. By detecting such errors in a relatively benign state, controllable system renewal can affords time for engineers to fix the source of the error accumulation. More importantly, the controllable system renewal module can ensure that unscheduled failovers, when they do occur, execute properly.

[0080] The Content Manager module can provide a secure billing interface to link operators with value-added service providers. The revenue management module can enable business partners access (e.g., through an internet or other GUI interface) to the revenue manager module's real-time functionality without the need for business partners to purchase and support a full system of their own.

[0081] The system can have flexible GUI applications for pricing management, customer management, partner management, and service enablement. For example, the system can have a Pricing Center/Management module. The pricing center/management module can have pricing management functionality, such as tools to quickly define a product and service catalog together with the associated rules for pricing and discounting.

[0082] The pricing management module can define pricing, promotions and service bundles with a unified pricing interface (e.g., one tool/one process) for any payment method. The pricing management module can use any attribute from within the rating record as part of the rating scheme. The pricing management module can support one-time non-recurring events (e.g., registration/cancellation charges, m-commerce, content, and various service usage) as well as prepaid support for recurring events of varying duration (e.g. weekly, monthly, multi-monthly, and annual events). The pricing management module can manage tiered, volume, and multi-service discounting options as well as user-defined discounting. The pricing management module can track time of day/week and special days. The pricing management module can group pricing options such as closed user groups and friends and family. The pricing management module can provide support for zone- and location-based pricing. The pricing management module can manage unlimited numbers of pricing metrics: transport based (per minute, per kilobyte, etc.), value-based (per ring tone, per game, per message, etc.), hybrid, or any metric that the CSP may wish to define in the future. The pricing management module can assign one or more balance impact to any number of balances assigned—monetary or non-monetary. The pricing management module can define proration rules. The pricing management module can define linkage between products and services to entries in the general ledger (G/L).

[0083] The system can have a customer management interface module. The customer management interface can support creation and management of customer and partner accounts, for example, natively within the revenue management system, via real-time or batch CRM/PRM integration, via integration with legacy applications, or combinations thereof.

[0084] The revenue management system can have other modules to activate, deactivate, provision, and maintain device-related information on services. For example, some services (e.g., GSM telephony) can be provisioned in real time and other services (e.g., high-speed Internet access) can have staged provisioning. The system can have one or more service manager modules to provide specific service management capabilities based on industry requirements for services and standards such as GPRS, GSM, WAP, LDAP, and SIM.

[0085] The revenue management system can support unlimited and near-linear scalability with little or no software modification and no loss of performance. As subscriber or transaction volume grows, operators can add capacity at any time through either vertical scaling (e.g., adding CPUs to an existing server) or horizontal scaling (e.g., deploying additional servers). With this additional capacity, the system's high performance and high availability can remain undiminished.

[0086] The operator can add the necessary hardware to support another TIMOS instance pair, for example, if growth in transaction volume approaches the capacity of existing TIMOS instances. The system is readily scalable by the addition of multiple databases such as Oracle RAC clusters, for example if TIMOS is not the limiting factor in the system's capacity. Figure 5—an extension of the minimal configuration of Figure 3—depicts a variation of multi-DB scalability.

[0087] The revenue management system can manage credit in a variety of customer-centric methods. For example, families can have separate pre-pay, and/or post-pay, and/or now-pay sub-accounts on the same family plan (e.g., if each member of the family wants a different payment scheme). Companies can divide accounts between personal and business use for the company's communications devices (e.g., an employee can make personal calls and business calls and be billed into separate accounts).

[0088] For service providers accustomed to billing via a monthly batch process that prepares, prints, and mails invoices to customers, customer-centric billing in the era of IMS means an end to business as usual. Instead, service providers must implement a more flexible real-time system that can manage a customer's credit and charge on the customer's terms, offering prepay and now-pay options as well as traditional postpaid invoicing.

[0089] Figure 6 illustrates the configuration for a benchmarking test for the revenue management system. The test was conducted at Hewlett-Packard's laboratory in Cupertino, California. The test was performed on a single HP Superdome computer with 72 1-GHz CPUs partitioned into multiple domains. Test driver software running on an 8-CPU partition simulated an authentic traffic load (1.5 million prepaid subscribers) through the revenue management system. The Connection Manager and Database Data Manager each also ran on 8-CPU partitions, whereas a single instance of the transaction in-memory object store (TIMOS) data manager ran on a 16-CPU partition. An Oracle RDBMS ran on another 16-CPU partition.

Table 2

Sessions per second	Operations per second	Average authorization latency (ms)	Sessions per second per CPU
179	494	34	9.41

[0090] Table 2 illustrates the benchmark test results. A session represents a user's access to the network from beginning to end. In the case of a prepaid voice call, for example, the session begins when, following authorization of the caller's payment, a callee answers the call. This session ends when the caller hangs up. In the case of, for example, a prepaid SMS message, the session, likely much shorter, begins immediately after payment authorization and ends once the message has been transmitted across the network.

[0091] Each session may comprise multiple operations. A prepaid voice call, for instance, typically comprises three operations: service authorization and, if granted, start accounting and stop accounting operations. A prepaid call may cause operations within the system, for example, for reauthorization and reservation of more minutes on the network in the case of long call durations. SMS messages generally require just two operations per message: authorization and stop accounting.

[0092] The system under test supported as many as 179 concurrent sessions per second--equivalent to 9.0 sessions per second per CPU-and 494 operations per second. Moreover, because the system is linearly scalable, the establishment of additional TIMOS instances and the inclusion of more CPUs can provide a proportionate performance increase to meet any conceivable load demand at five-nines service availability.

[0093] A scaled-up version of the benchmark test system can support tens of millions of subscribers. The average authorization latency in the benchmark test results is 34 milliseconds (i.e., a substantially instantaneous response).

[0100] It is apparent to one skilled in the art that various changes and modifications can be made to this disclosure, and equivalents employed, without departing from the spirit and scope of the invention. Elements shown with any embodiment are exemplary for the specific embodiment and can be used on other embodiments within this disclosure.

CLAIMS

We claim:

1. A computer system configured to manage revenue for real-time charging for telecommunication services for at least one prepaid and/or postpaid and/or now-pay account, the system comprising: a gateway layer, a revenue capture layer, a database layer, and a storage layer.

2. The system of Claim 1, further comprising an in-memory object store, wherein the object store comprises RAM memory.

3. The system of Claim 2, wherein the revenue capture layer comprises the in-memory object store.

4. The system of Claim 1, wherein the system is scalable with regard to processors.

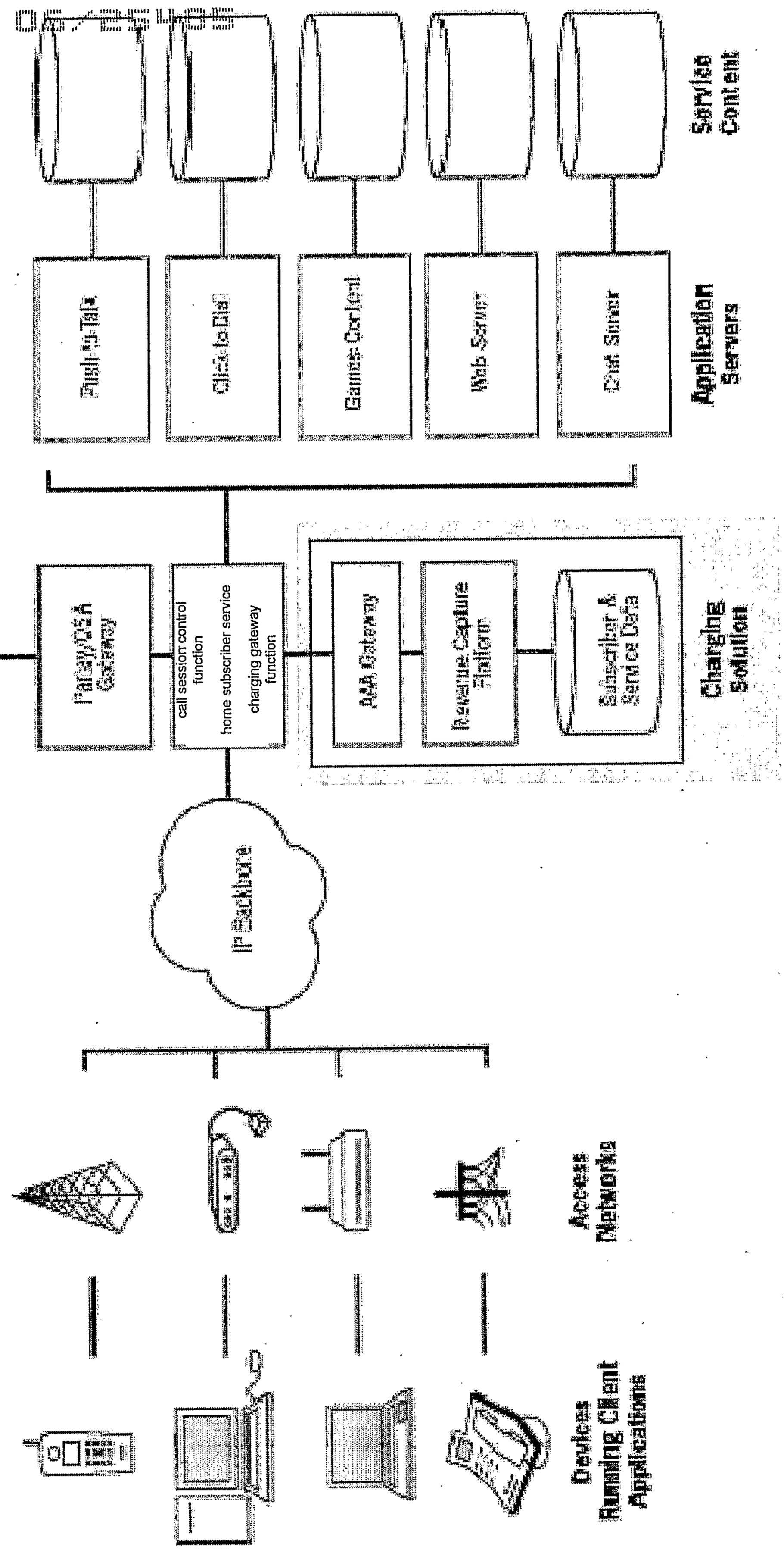
5. The system of Claim 1, wherein the system is scalable with regard to memory.

6. The system of Claim 1, wherein the system is configured to interface with an IMS account.

7. A revenue management system configured to perform convergent real-time charging for prepaid, postpaid, and now-pay telecommunication network user accounts.

8. The system of Claim 7, wherein the system is configured to interface with an IMS account.

Figure 1—


To other operators' networks
Parlay/OSA Gateway
call session control function
home subscriber service
charging gateway function
AAA Gateway
Revenue Capture Platform
Subscriber & Service Data
Charging Solution
IP Backbone
Click-to-Dial
Web Server
Chat Server
Application Servers
Service Content
Access Networks
Devices Running Client Applications

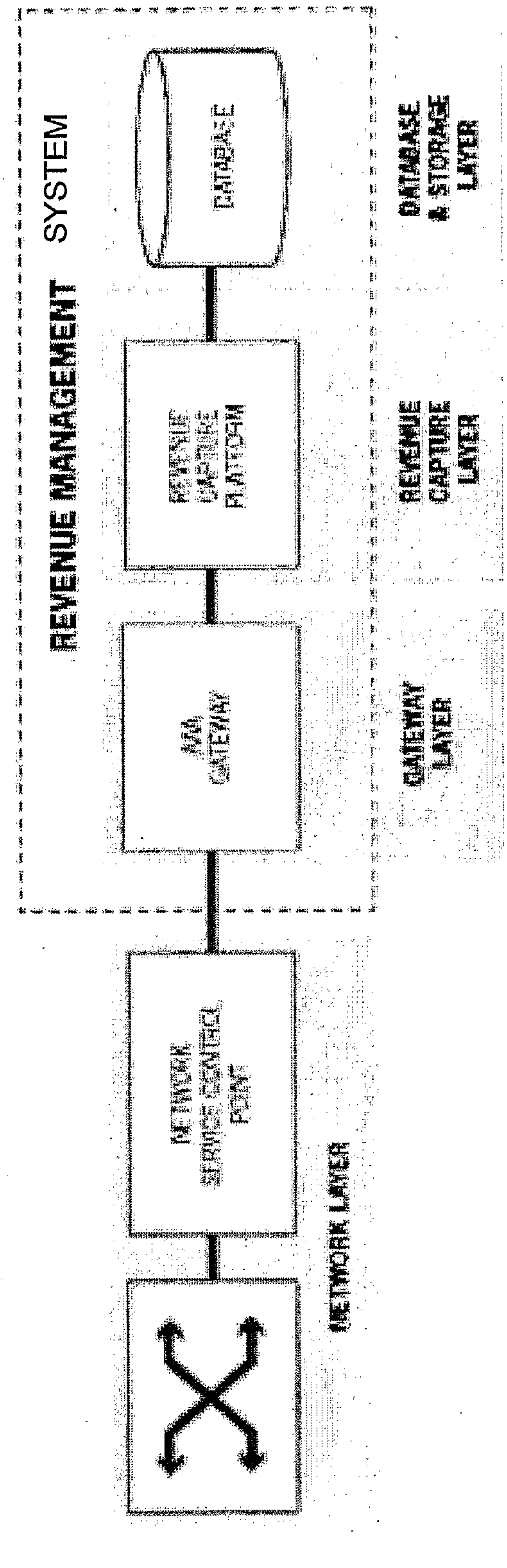

REVENUE MANAGEMENT SYSTEM
DATABASE & STORAGE LAYER
REVENUE CAPTURE LAYER
GATEWAY LAYER
NETWORK LAYER

Figure 2

Figure 3

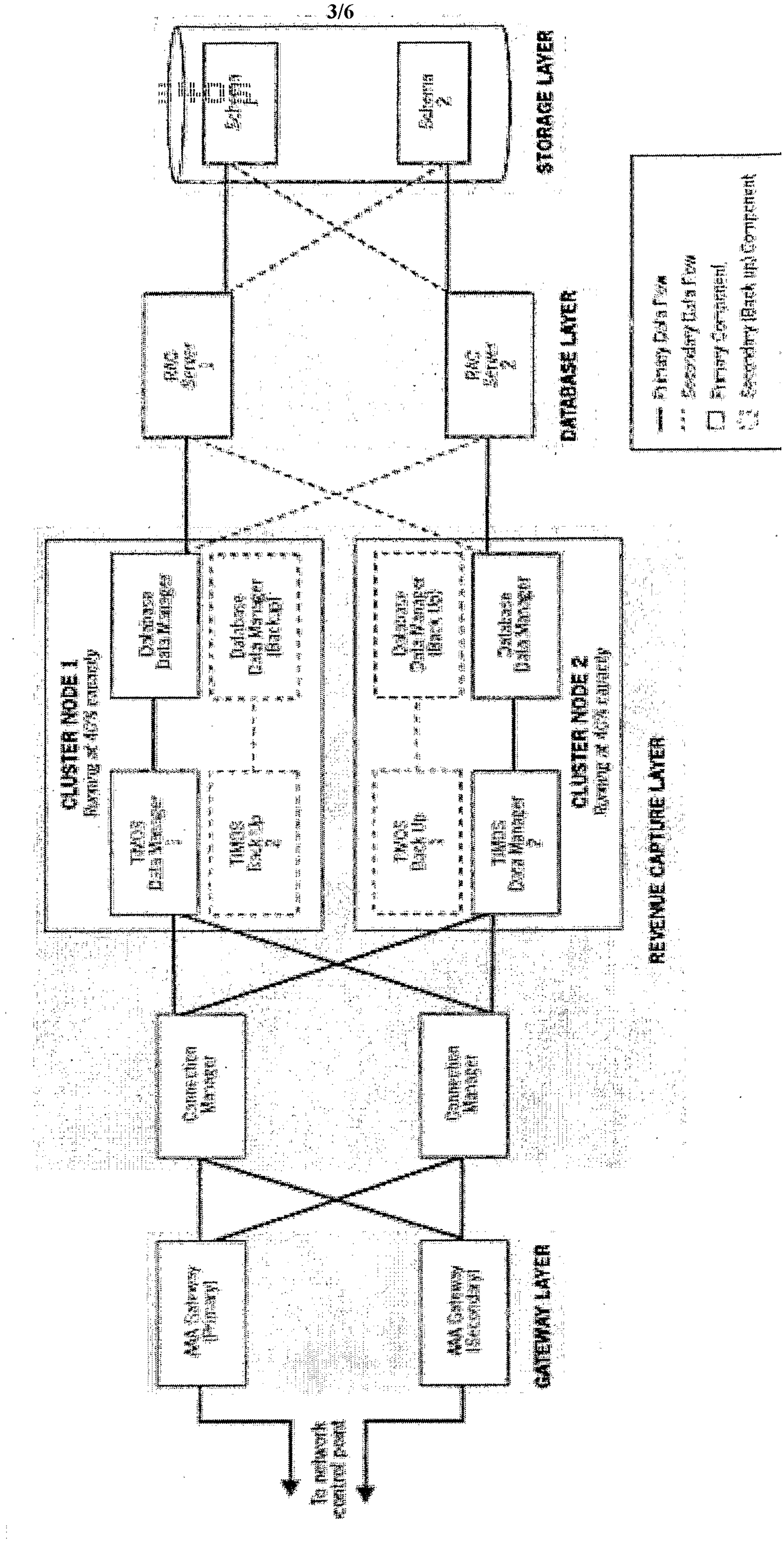

STORAGE LAYER
Schema 1
Schema 2
DATABASE LAYER
RAC Server 1
RAC Server 2
CLUSTER NODE 1
Database Data Manager
Database Data Manager (Backup)
TMOS Data Manager 1
TMOS Back Up 2
CLUSTER NODE 2
Database Data Manager (Back Up)
Database Data Manager
TMOS Back Up 1
TMOS Data Manager 2
REVENUE CAPTURE LAYER
Connection Manager
Connection Manager
AAA Gateway (Primary)
AAA Gateway (Secondary)
GATEWAY LAYER
To network control point
Primary Data Flow
Secondary Data Flow
Primary Component
Secondary (Back up) Component

Figure 4

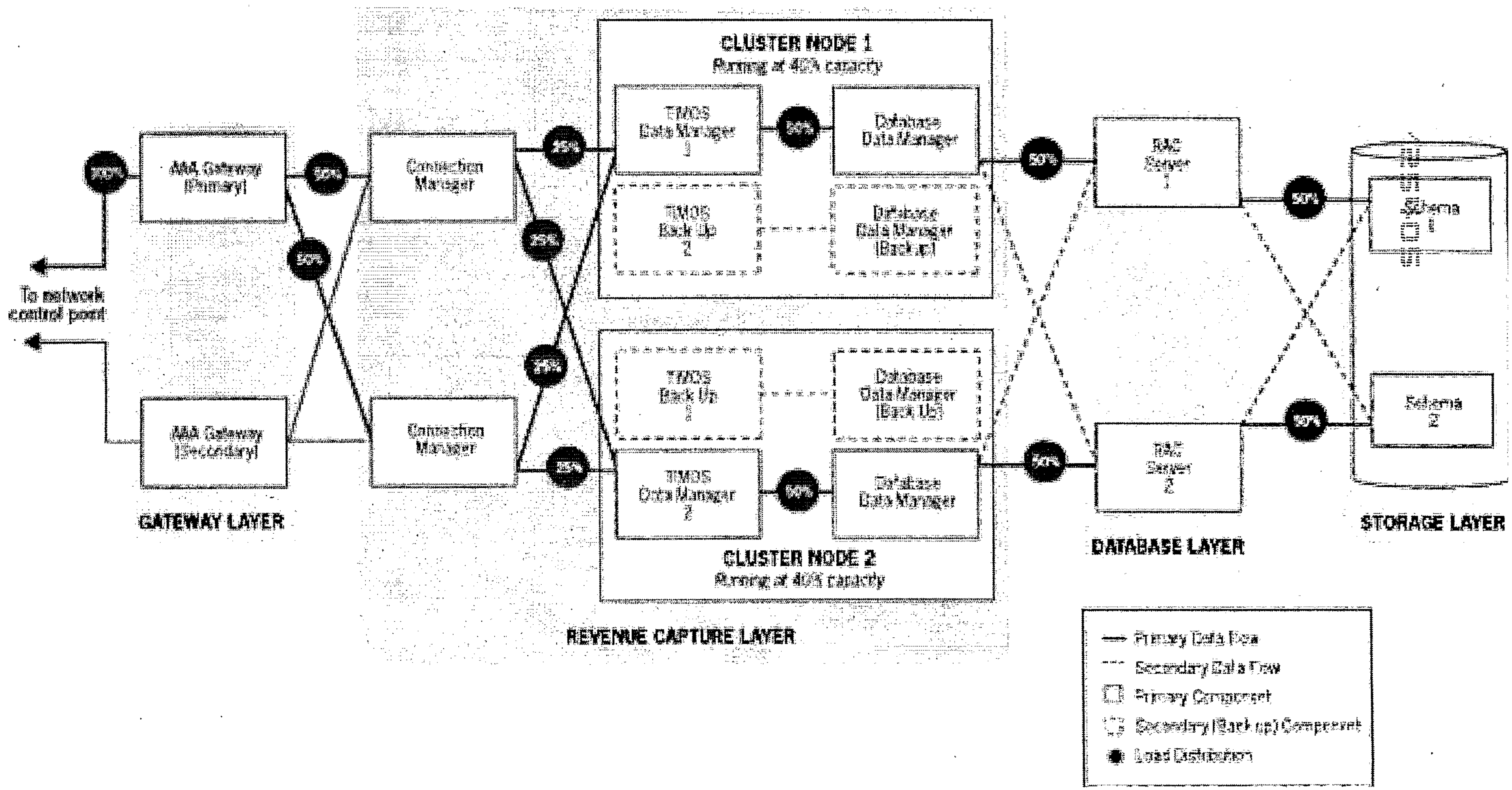

CLUSTER NODE 1
Running at 40% capacity
TMOS
Data Manager
1
Database
Data Manager
TMOS
Back Up
2
Database
Data Manager
(Back up)
AAA Gateway
(Primary)
AAA Gateway
(Secondary)
Connection
Manager
Connection
Manager
To network
control point
GATEWAY LAYER
TMOS
Back Up
1
Database
Data Manager
(Back Up)
TMOS
Data Manager
2
Database
Data Manager
CLUSTER NODE 2
Running at 40% capacity
REVENUE CAPTURE LAYER
RAC
Server
1
RAC
Server
2
DATABASE LAYER
Schema
1
Schema
2
STORAGE LAYER
Primary Data Flow
Secondary Data Flow
Primary Component
Secondary (Back up) Component
Load Distribution

Figure 5

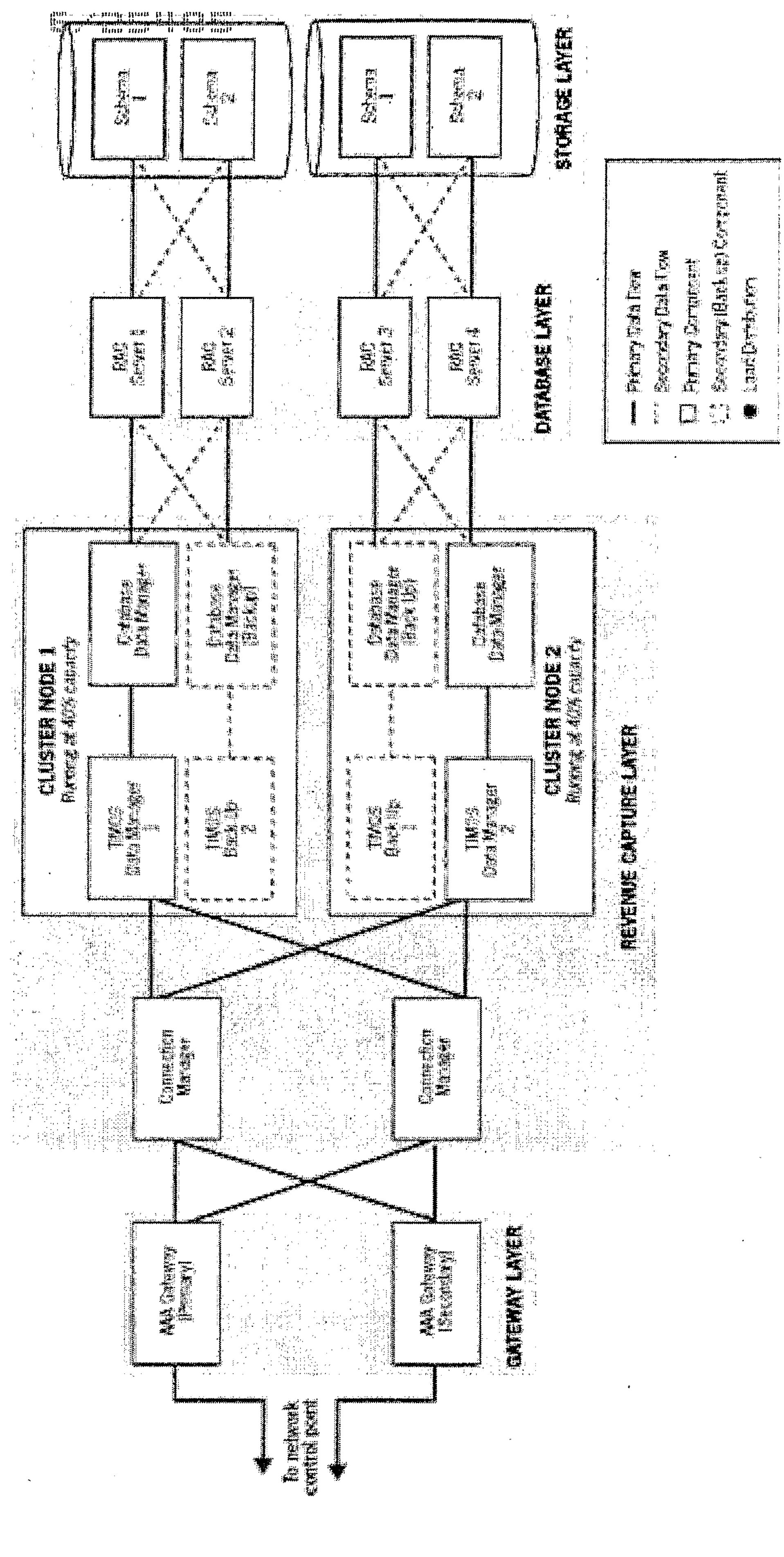
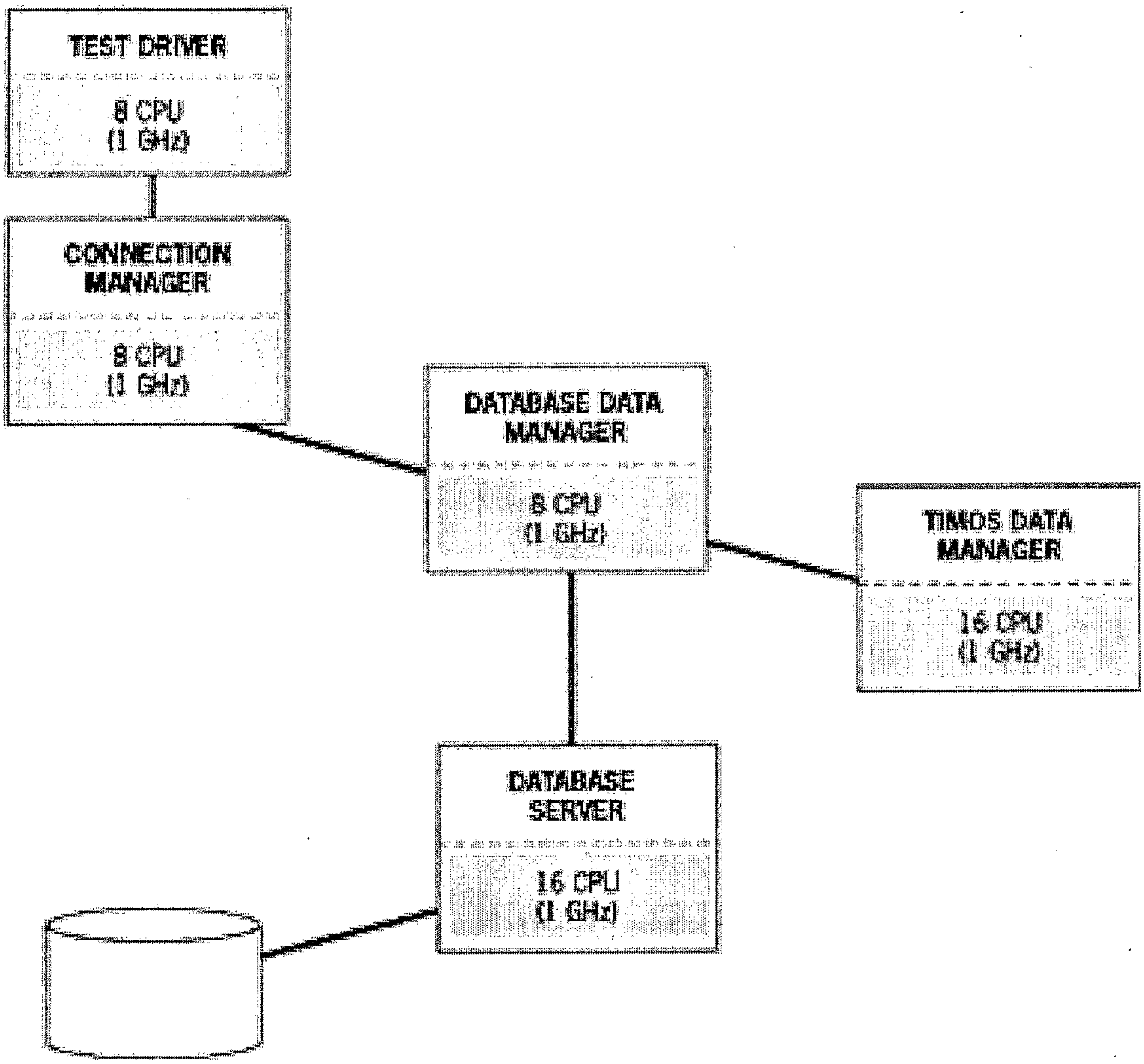

STORAGE LAYER
DATABASE LAYER
REVENUE CAPTURE LAYER
GATEWAY LAYER
Schema 1
Schema 2
RAC Server 1
RAC Server 2
RAC Server 3
RAC Server 4
CLUSTER NODE 1
CLUSTER NODE 2
Database Data Manager
Connection Manager
Connection Manager
AAA Gateway (Primary)
AAA Gateway (Secondary)
To network control point
Primary Data Flow
Secondary Data Flow
Primary Component
Load Distribution

Figure 6


TEST DRIVER
8 CPU
(1 GHz)
CONNECTION MANAGER
8 CPU
(1 GHz)
DATABASE DATA MANAGER
8 CPU
(1 GHz)
TIMOS DATA MANAGER
16 CPU
(1 GHz)
DATABASE SERVER
16 CPU
(1 GHz)