Large Telco Deploys HPE Shadowbase Continuous Availability Architecture for Scale-Out to Handle Massive Growth in Smart Phone Usage

A Gravic, Inc. Case Study

Large Telco Deploys HPE Shadowbase Continuous Availability Architecture for Scale-out to Handle Massive Growth in Smart Phone Usage

Executive Summary

A major international telephone company based in the United States originally provided landline long distance telephone services. It ultimately grew to be one of the major long distance providers as measured by number of subscribers. With the advent of mobile phone services, it aggressively expanded its cellular network.

However, as the company entered the new millennium, it found that its cellular traffic was quickly outgrowing its landline traffic, so it decided to focus on mobile communications and spun off its landline business. It became one of the largest U.S. cellular network operators, providing a full range of mobile phone and Internet services.

In the early 1990s, the telecommunications carrier implemented an HPE NonStop server system to manage cell phone billing and fraud detection. HPE Shadowbase software solutions were selected to interconnect the carrier's HPE NonStop Home Location Registers (HLRs) with the new central billing system to keep the billing system up-to-date with subscriber call activity.

However, the marketplace is no longer comprised of just cell phones, but rather, *smart* phones. The management of smart phone features is far more complex than it is for the older, simpler cell phones, and the HLRs could no longer support all that is required to provision and manage smart phones. Therefore, the company implemented a new distributed active/active HPE NonStop server architecture to provision smart phones and to manage their more complex billing and application requirements.

After an exhaustive review of the options available, the carrier again selected Shadowbase software to interconnect the multiple new NonStop servers. These options included an active/active pair that serve as the continuously available heart of the new system, and multiple "scale-out" read-only query nodes from which the HLRs obtain smart phone provisioning information required to establish calls and verify services. Shadowbase technology provides the data replication infrastructure between these multiple nodes to support both the continuous availability of the core application, and to keep the data on the read-only nodes synchronized with the database of record.

Table of Contents

Large Telco Deploys HPE Shadowbase Continuous Availability Architecture for Scale-out to Handle Massive Growth in Smart Phone Usage **2**

Executive Summary **2**

Large Telco Deploys HPE Shadowbase Continuous Availability Architecture for Scale-out to Handle Massive Growth in Smart Phone Usage **4**

The Growth of Mobile Phones **4**

The Telco's Early Cell Phone System **5**

What is a Home Location Register (HLR)? 5
HPE's Active/Active NonStop HLRs 6
The Telco's Cell Phone Billing System 6
Fraud Detection 7

The Telco's Move to Smart Phones **8**

The New Smart Phone Billing and Provisioning System 9
Active/Active Availability with Scale-out 9
Failover 10

Summary **10**

International Partner Information **11**

Gravic, Inc. Contact Information **11**

Table of Figures

Figure 1 – Mobile Phone Growth 4
Figure 2 – What is an HLR? 5
Figure 3 – HPE's NonStop Active/Active HLR 6
Figure 4 – The Telco's Original Billing System 7
Figure 5 – Fraud Detection 8
Figure 6 – The Telco's Smart Phone Billing and Provisioning System 9

Large Telco Deploys HPE Shadowbase Continuous Availability Architecture for Scale-out to Handle Massive Growth in Smart Phone Usage

A major international telephone company ("telco") based in the United States traces its roots to over one-hundred-years ago, when it was founded to deploy landline telephone services to rural areas in the U.S. It ultimately grew to be one of the major long-distance providers as measured by number of subscribers.

However, as it entered the new millennium, it found that its cellular traffic was quickly outgrowing its landline traffic. It decided to focus on mobile communications and spun off its landline business. It became one of the largest U.S. cellular network operators, providing a full range of mobile phone and internet services.

In the early 1990s, the telco implemented an HPE NonStop server system to manage cell phone billing and fraud detection. Shadowbase software solutions were selected to interconnect the carrier's NonStop Home Location Registers (HLRs) with the new central billing system to keep the billing system up-to-date with subscriber call activity.

Fast forward to the present: the marketplace is no longer comprised of just cell phones, but rather, *smart* phones. The management of smart phone features is far more complex than it is for the older, simpler cell phones. The HLRs could no longer support all that is required to provision and manage smart phones. Therefore, the Telco implemented a new, distributed multi-server HPE NonStop system to provision smart phones and manage their more complex billing requirements. The carrier again selected Shadowbase technology to interconnect the multiple new HPE NonStop servers, including an active/active pair that serves as the continuously available heart of the new system.

The Growth of Mobile Phones

Surprisingly, given the ubiquitous proliferation of mobile phones in our current life styles, mobile phone services have only been with us for a little over two decades. They started out as limited analog phones. However, they went digital in 1991 with the introduction of 2G digital cellular technology. The capacity of cellular networks increased in 2001 with the introduction of 3G networks, and now carriers are implementing the new 4G networks (currently generally constrained to 4G LTE).

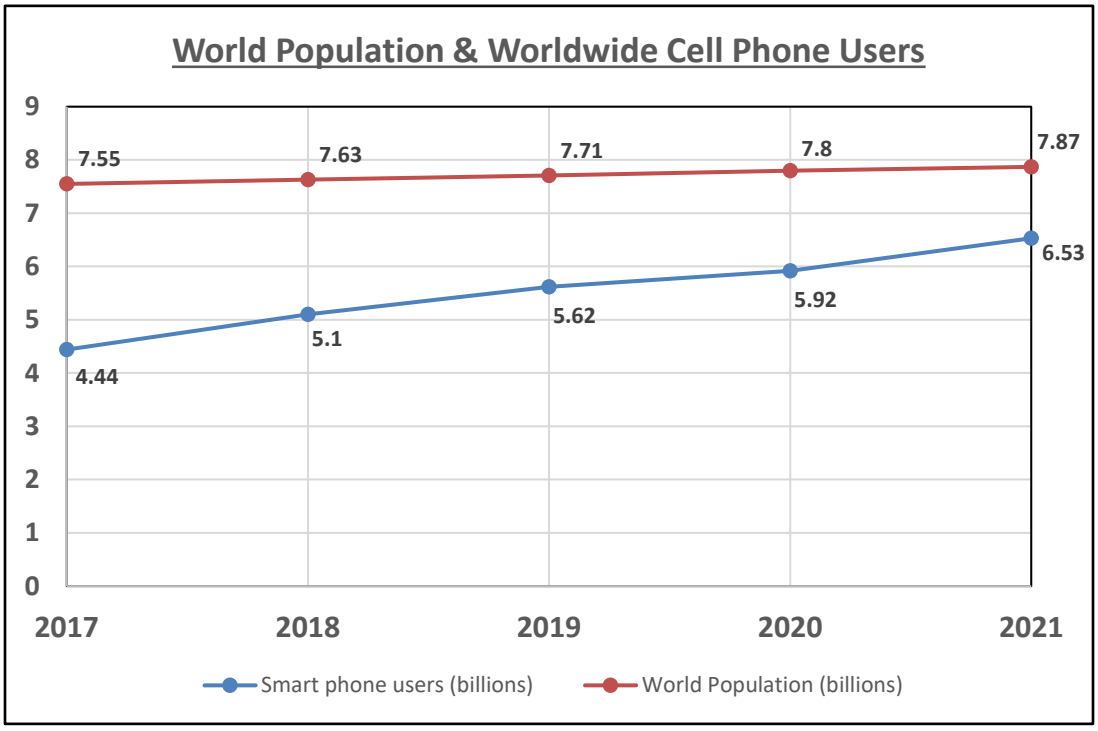

Figure 1 – Mobile Phone Growth

Since 1990, the number of mobile phone subscribers (including cell phones, smart phones, and tablets) has grown from twelve million subscribers to over six billion subscribers (**Error! Reference source not found.**). This number is especially telling, since the total population of our planet totals a little under eight billion people! Clearly, many people have multiple phones.

The major spurt in mobile phones was driven by the introduction of smart phones. The popular Android and iPhone mobile phones began to attract massive amounts of users in the 2007-2008 timeframe. Developing countries account for over 77% of the world's cell phone subscriptions and, these phones are primarily smart phones.

The Telco's Early Cell Phone System

When the telco entered the mobile cell phone business, it depended upon its HLRs to manage the cell phones. It implemented a NonStop Billing System to receive call information from the HLRs so that it could bill its customers.

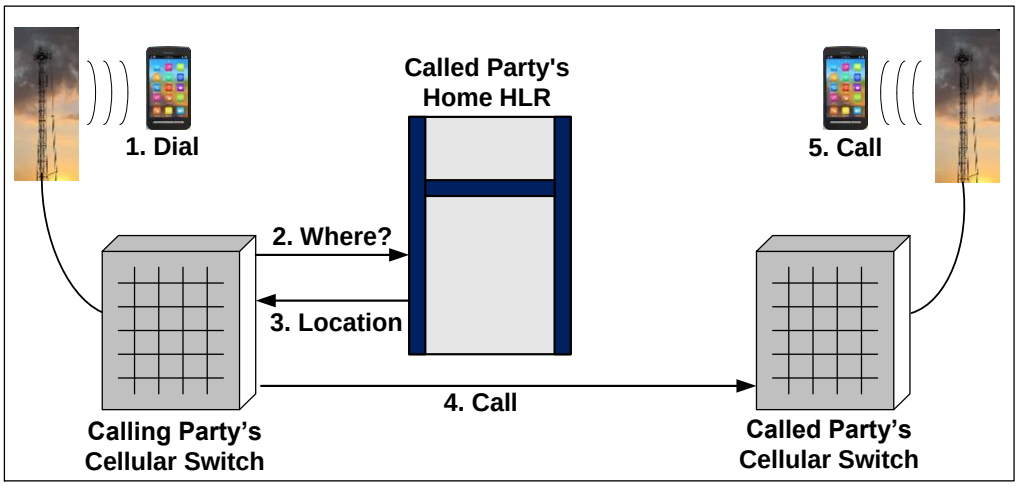

Figure 2 – What is an HLR?

What is a Home Location Register (HLR)?

The HLR is the heart of a digital cellular network. There are hundreds of HLRs distributed around the world. Every subscriber is assigned to an HLR, known as the subscriber's home HLR. The mobile phone number determines this home HLR. The primary purpose of the home HLR is to know where its subscribers are at any point-in-time, to manage authorized features, and to record billing information.

As shown in Figure 2, when a subscriber first turns on his mobile phone, he is connected to the closest cell phone tower. That tower is connected to a cellular switch that notifies the subscriber's home HLR as to his location. When the subscriber calls another party, that party's home HLR is contacted to determine the location of the called party. The involved cellular switches then establish a connection between the parties.

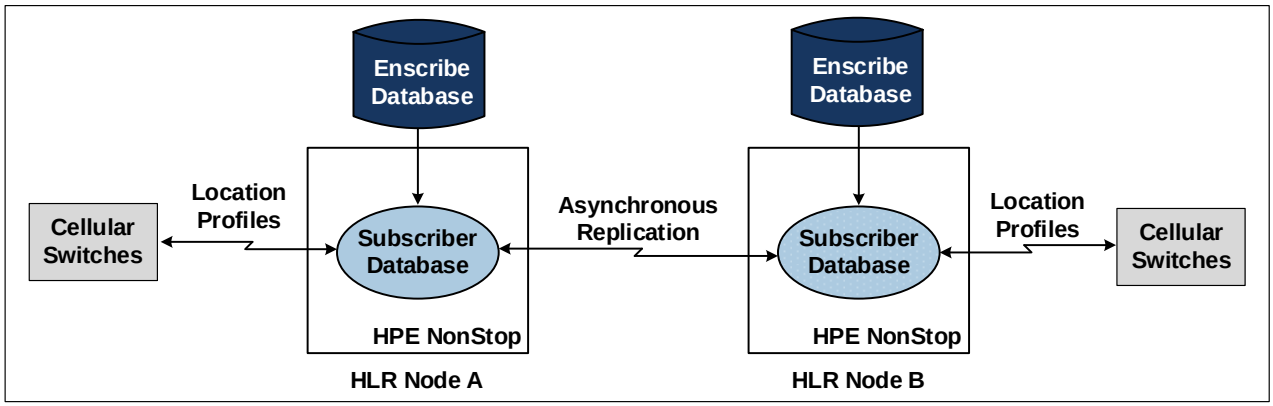

Figure 3 – HPE's NonStop Active/Active HLR

HPE's Active/Active NonStop HLRs

Clearly, the HLRs are a vital part of any cellular network, must always be available, and therefore can be classified as *mission-critical*. If an HLR goes down, all of the subscribers homed on it are out-of-service. To maintain continuous availability, the telco chose HPE's HLR application running on HPE NonStop Server systems. The HPE HLR comprises an active/active HPE NonStop server pair (

Figure 3) that shares the subscriber load between the two systems. If an HPE NonStop server fails, all call activity is routed to the surviving server.

The Telco's Cell Phone Billing System

When the telco inaugurated its mobile cellular service in the early 1990s, it needed to bill for subscriber activity, so it implemented a Billing System using HPE NonStop servers. As shown in

Figure 4, when a mobile call is completed, the originating cellular switch (the switch that is serving the calling party) generates a call detail record (CDR) that contains information about the call, such as the calling party, the called party, the time and date of the call, its duration, and any special services that were used. The cellular switch to the calling party's home HLR then sends the CDR.

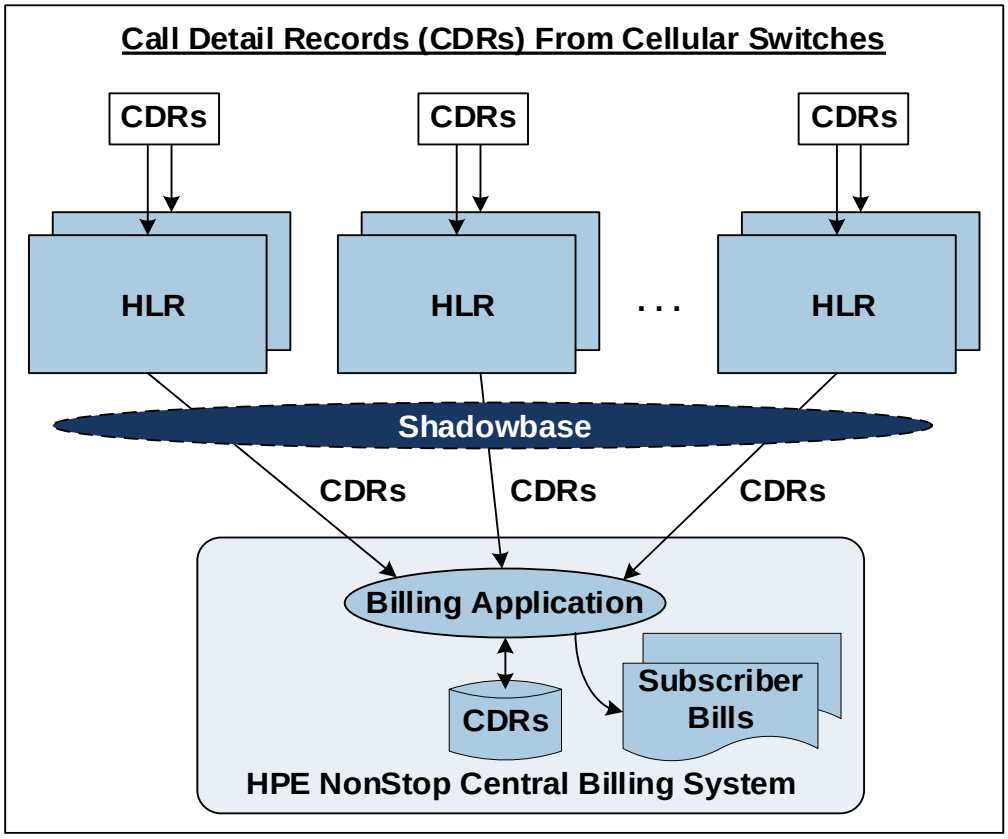

Figure 4 – The Telco's Original Billing System

The HLRs send their CDRs to the Billing System, where they are stored in its billing database. The telco chose the Shadowbase replication engine to send the CDRs from the HPE NonStop HLRs to the HPE NonStop Billing System. The CDRs are small, but they represent a very high volume (hundreds to thousands of CDRs per minute from each HLR). With its process-to-process, multithreaded replication, the Shadowbase architecture manages this volume with very small replication latency intervals, which is important because any fault in the replication pipeline means that the CDRs currently being replicated may be lost, resulting in lost revenue for the business. The CDRs in the Billing System's database are used to generate monthly bills to the company's subscribers.

Fraud Detection

The CDR activity in the billing database is valuable to the telco for more than just billing. It represents a data warehouse that can be used to mine a great deal of data about its subscriber base. What is the geographic distribution of calls? What is the time distribution of calls? Where should additional cell towers be located? What ancillary services are most used?

Another important use of this data warehouse is fraud detection. For instance, the CDR identifies the location of the mobile phone. If that phone makes a call from the U.S. and a short time later makes a call from India, then it is clear that the phone has been cloned. Hackers can intercept wireless traffic, obtain the mobile phone's

identification number, and send that number to an accomplice who can enter the number into his phone's SIM card. Cloned phones can then make apparently legitimate calls, and the cost of the calls will be billed to the unsuspecting subscriber. The company has to absorb the cost of these illegitimate calls.

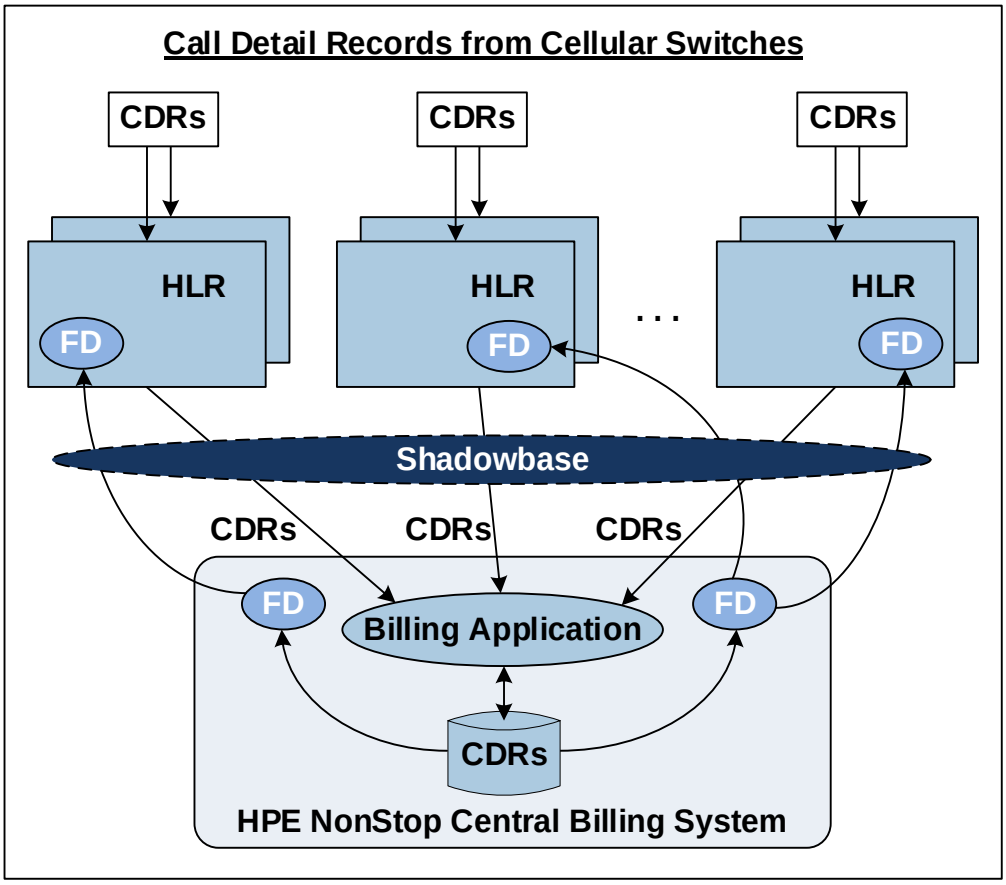

Figure 5 – Fraud Detection

The telco therefore uses the CDR information to detect a range of suspected fraudulent actions. It will notify the mobile phone's home HLR of the potential fraud (
Figure 5). The HLR will block further calls until the situation has been resolved.

Shadowbase replication is also used to send directives related to fraudulent use of mobile phones from the Billing System to the HLRs. As time went on, the cellular systems were improved to thwart many of the fraudulent strategies used by hackers. For instance, encryption substantially solved the phone-cloning problem. Shadowbase technology is able to distribute useful data in real-time in both directions, from the HLRs to the Billing System, and from the Billing System to the HLRs.

The Telco's Move to Smart Phones

As smart phones began to take over the mobile marketplace in the mid-2000s, it became clear to the telco that its current system could not handle the transition. The biggest problem was the provisioning of the extended smart phone features. The early management of cell phones involved only a few services, such as telephone calls, text messaging, voice mail, email, contacts, calendars, and photos. Smart phones complicated this management by an order of magnitude. For instance:

- Smart phones can browse the Internet using any of the popular search engines.
- Smart phones can download special applications (apps) to provide thousands of specialized application services.
- Smart phones can provide GPS directions to destinations.
- Smart phones can download and stream movies and TV shows, allowing users to watch them wherever and whenever they want.
- In some cases (e.g., the iPhone), a simulated operator (Siri) will respond to voice queries, for example, where to find the nearest gas station.

The HLR needed to know what features the subscriber had signed up for, and the many new features were more than the current HLR application was capable of handling. Furthermore, billing was much more complicated. Not only were there voice plans that prepaid for a certain number of minutes of talking per month, but now there were data plans that prepaid for a certain number of gigabytes of data transferred, which complicated the CDRs. Not only must call durations be recorded, but data usage and application services used by the smart phone need to be recorded as well. Modifications to the Billing System were necessary in order to take all of these additional factors into account when preparing the customers' billing statements.

The New Smart Phone Billing and Provisioning System

Therefore, the telco issued a Request for Proposal (RFP) for a new system, which required not only an expanded billing system, but also a repository for all smart phone features that the HLRs could access when placing a call.

Availability of services is a critical requirement for the new system. Since it is handling smart phone provisioning, if the system goes down, the HLRs will have no idea of the features to which a smart phone is entitled. Service might be terminated with the result that no new calls can be made. Furthermore, valuable billing information for calls in progress would be lost.

In addition, the system has to provide virtually unlimited scale-out capabilities. With the rapid growth of smart phone usage, the capability of the system to respond quickly to HLR queries for the features of smart phones has to keep up with rapidly rising demand.

In responding to the RFP, Gravic worked with the telco to design a continuously available architecture that could easily scale-out to handle additional provisioning traffic as the number of smart phones grows and the complexity of their services increase. After a lengthy 18-month trial/proof-of-concept period, where the company evaluated and tested multiple competing solutions from various replication product providers, it awarded the contract to Gravic and its Shadowbase data replication engine.

Active/Active Availability with Scale-out

The system developed years ago for cell phone service is still in operation and provides the billing and other data warehouse functions for cell phones. Likewise, cell phone features are still managed by the HLRs. However, all billing and provisioning services for smart phones are provided by the new system.

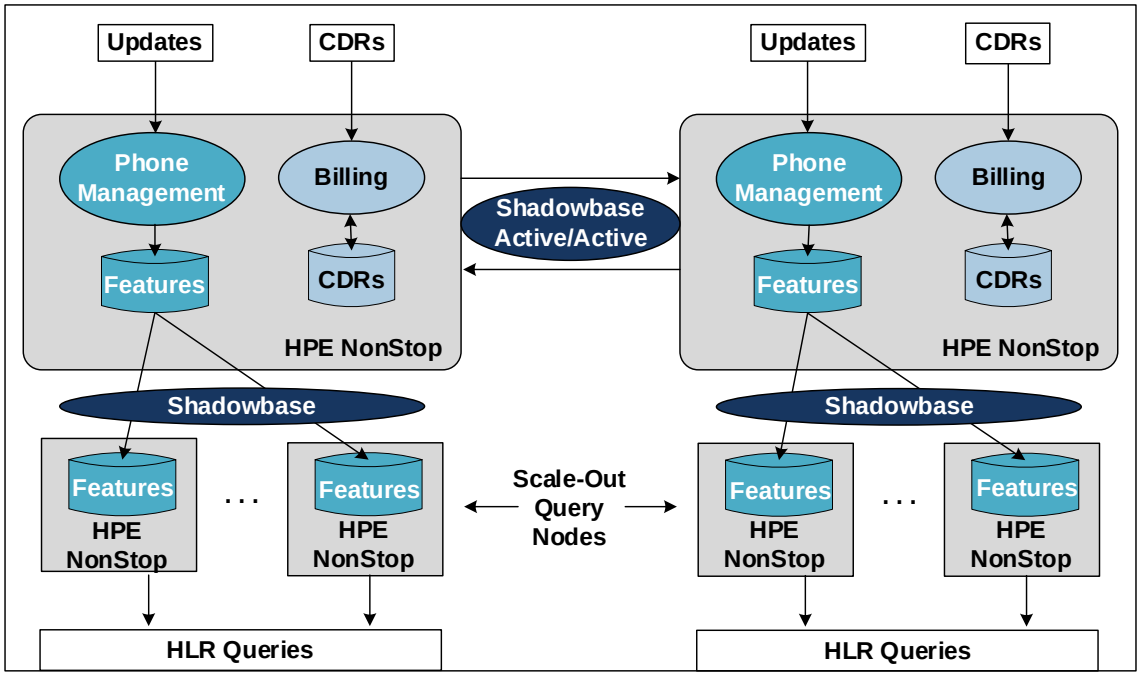

Figure 6 – The Telco's Smart Phone Billing and Provisioning System

The enhanced smart phone Billing and Provisioning System is shown in Figure 6. A NonStop active/active pair of master-master (or multi-master) systems handles the billing and smart phone management functions. One master system is located in the Midwest U.S., and the other master system is located more than a thousand miles away on the U.S. west coast. Shadowbase software provides the bi-directional data replication to support active/active operations between the two master systems. The two master systems share the billing and feature management load. Data collisions are avoided by partitioning mobile phone numbers between the two systems. Additionally, if one system fails, then all activity is routed to the surviving system with no service outage.

For smart phones, the HLRs now send the enhanced CDRs to the new Billing and Provisioning System. The new billing application tracks many forms of usage, including voice, data, browsing, streaming, GPS, apps, and others. All of these uses affect the customers' bills. Furthermore, the NonStop active/active master servers provide a repository of the features for which each smart phone user has subscribed, by storing them in a Features database. All CDRs and all feature updates received by one system in the active/active pair are replicated to the other system so that the databases of the two systems are synchronized to include CDRs and updates for all subscribers.

To provide scale-out, additional HPE NonStop server nodes are provided as read-only query processors to which the HLRs can direct their queries during call establishment for a smart phone's authorized features. To support the efficient processing of queries, the Features database is replicated from a master system to each query node via the Shadowbase data replication engine. Because of the bi-directional replication used in the active/active system, both of the active/active nodes have identical Features databases, so that all query nodes have the same data. Though the feature update load is relatively small, the query load is intensive as there must be an HLR query for each call being established. By replicating the Features database to the query nodes, the primary system is not burdened with query processing, and the architecture can easily scale to handle any load as the number of smart phones increases.

The query nodes are distributed near population centers to improve query performance, thus shortening call establishment time. In the initial deployment, the telco is using six query nodes, all in the U.S. As activity increases, more query nodes can be added as necessary. At some point, additional active nodes and query nodes may be added to international sites. The primary active/active nodes and the query nodes are all configured identically. Each node initially includes a NonStop NB54000c Server with four quad-core blades.

Failover

Collocated with each master system is at least one query system. If a master system fails, then the collocated query system is promoted as the new master and takes over the bi-directional replication with the other master. When a query system is promoted as a master, it will typically shed its query function and the load will be redistributed to the remaining query nodes. Regardless, all of the master nodes can also serve the query role should demand dictate the need.

The same procedure is used if a master node needs to be upgraded. It is taken out of service and replaced with a collocated query node. When the upgrade is completed, the original master is returned to service, freeing the query node to be upgraded or to resume processing HLR queries. By using this procedure, the smart phone system maintains geographical fault-tolerance even during maintenance upgrades. If an entire data center is lost, all CDRs and updates are routed to the surviving data center. A query node in that data center is promoted to a master to maintain active/active redundancy and fault-tolerance.

Summary

The telco has been a Shadowbase customer since 1991 when it started using HPE Shadowbase software solutions to communicate between its HLRs and its cell phone billing system. The use of Shadowbase data replication was so successful over the years that the business again chose Shadowbase technology to integrate its new smart phone Billing and Provisioning System to build a continuously available, scale-out solution.

With its choice of HPE NonStop servers for fault-tolerance and massive query processing and its choice of HPE Shadowbase solutions to provide active/active geographical continuous availability and system integration, the company is positioned to support its rapidly expanding smart phone services well into the future.

International Partner Information

Global

Hewlett Packard Enterprise
6280 America Center Drive
San Jose, CA 95002
USA
Tel: +1.800.607.3567
www.hpe.com

Japan

High Availability Systems Co. Ltd
MS Shibaura Bldg.
4-13-23 Shibaura
Minato-ku, Tokyo 108-0023
Japan
Tel: +81 3 5730 8870
Fax: +81 3 5730 8629
www.ha-sys.co.jp

Gravic, Inc. Contact Information

17 General Warren Blvd.
Malvern, PA 19355-1245
USA
Tel: +1.610.647.6250
Fax: +1.610.647.7958
www.shadowbasesoftware.com
Email Sales: shadowbase@gravic.com
Email Support: sbsupport@gravic.com

Hewlett Packard Enterprise Business Partner Information

Hewlett Packard Enterprise directly sells and supports Shadowbase Solutions under the name ***HPE Shadowbase***. For more information, please contact your local HPE account team or visit our website.