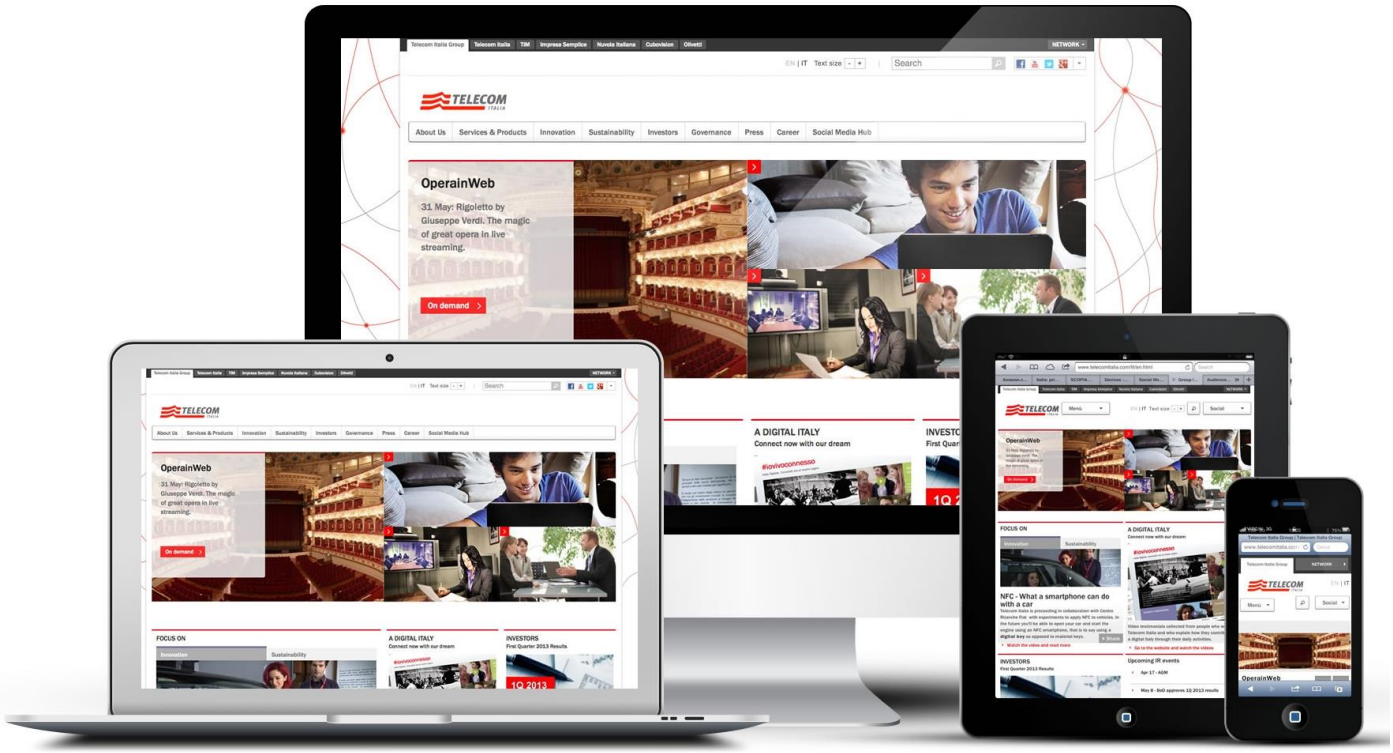
GRAVIC®
Shadowbase

Telecom Italia's Continuously Available Mobile Services

A Gravic, Inc. Case Study



Executive Summary

The Telecom Italia Group provides fixed-line and mobile telephone services to the Italian marketplace as well as mobile services to subscribers in other countries. As the predominant mobile service provider in Italy, the group uses HPE NonStop active/active systems to ensure the continuity of some of its critical mobile services.

The Telecom Italia Group's strategic initiatives include accelerating the convergence between fixed and mobile telephones, broadband Internet, and media content. High-profile brands such as Telecom Italia, Olivetti, Telecom Italia Mobile (TIM), and others mark the Telecom Italia Group's activities throughout the communications industry.

Telecom Italia Mobile

Telecom Italia is the largest cell phone service operator in Italy, providing coverage to over 95% of the country via its TIM-branded mobile services. The TIM brand is also recognized in Europe, the Mediterranean basin, and in South America. The TIM network is a dual-band mobile network, which provides GSM, 3G and LTE services, and supports prepaid roaming, wireless application protocol (WAP) navigation, high-speed data services, and international videophone.

With over 100 million mobile phone lines, 30 million of which are in Italy, TIM has become the major strength of the international presence of the Telecom Italia Group. Via TIM, Telecom Italia is Brazil's number two mobile carrier, with over 70 million mobile phone lines. Telecom Italia formerly provided mobile services to subscribers in other countries prior to divesting itself of operations in Peru, Venezuela, and Greece.

The Telecom Italia Group is a member of the FreeMove Alliance, which forms the largest mobile community in the world. The FreeMove Alliance provides seamless service to almost 400 million customers around the world, including 39 European countries, such as Italy, Great Britain, France, Spain, the Netherlands, Germany, Belgium, and Switzerland. This membership explains TIM's motto, *Vivere senza confini* (Living without borders).

Continuously Available Services

A critical attribute of telephone services is that they must be dependable. To provide extreme reliabilities in its network, TIM uses HPE's Open Call Intelligent Network Server (INS), a NonStop system that provides telephone SS7 switching services. Highly reliable operations are provided by configuring INS as two or more nodes, which are kept synchronized by HPE's mated-pair technology in an active/active-like configuration.

In addition to services provided by INS, TIM supports additional special services that have been implemented by Telecom Italia. Among these services is Small Message Services (SMS), which is a service for sending small text messages, entered by one subscriber to another subscriber (between either mobile or fixed line phones); the messages are stored in the system for forwarding to the recipient. If the receiving subscriber's cell phone is not currently communicating with the network, the message is held until the next time the cell phone logs on to the network. At that time, the text message is sent to the receiving subscriber.

Redundancy Requirements

When Telecom Italia first implemented its SMS services on HPE's INS running on an HPE NonStop S74000 server, it found that the server was handling 1,000 transactions per second; and this volume was growing. Clearly, the company had to prepare for future significant expansion.

Furthermore, though the NonStop servers were fault-tolerant, the company had to be prepared to recover from a technical, human, or natural disaster that might take down its data processing center. Therefore, it decided to expand its INS system to a two-node active/active system. Each system normally processes half of the transaction load and sends updates via HPE Shadowbase data replication software to its companion system. With this configuration, the TIM network now withstands the loss of one of its data centers by simply rerouting all transactions to the surviving system. Additionally, capacity is easily expanded by adding nodes to the active/active application network.

System Configuration

Telecom Italia installed one INS node in Milan (North Central Italy) and one in Rome (West coast), as shown in Figure 1. These locations provided sufficient geographic separation for disaster tolerance and offered an efficient network topology to support cell tower networking. Both nodes are sized so that each can handle the entire network load. In this way, there will be no degradation of service if one node becomes unavailable.

TIM's cell towers are connected to the INS sites by a dedicated cell tower network. Each cell tower knows its primary INS node and normally routes all of its traffic to that node. If that node fails (or is taken down for maintenance or upgrades), the cell tower will reroute all of its traffic to the surviving node. The routing rules can be changed so that the system's load is balanced when necessary.

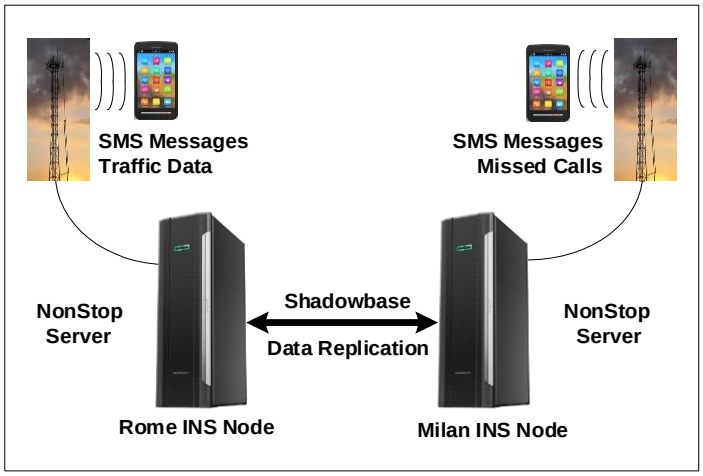


Figure 1 – TIM's INS Services

Database Synchronization

Each INS node in the TIM network maintains a complete database for the entire system. As changes are made to a data item in one database, that change is replicated by Shadowbase software to the other database, therefore the two databases are kept synchronized. Shadowbase data replication is asynchronous so that it does not affect the responsiveness of the application and is bi-directional so that changes are replicated in both directions.

Data Collisions and Relative Replication

As cell tower traffic is received by an INS node, that node updates subscriber records with the number of calls, the number of minutes used, and other information such as roaming so that the subscriber can be billed. It also stores SMS messages for routing to subscribers and tracks voicemail messages waiting for delivery.

Though all traffic for a given subscriber is being routed to only one INS node at a time, depending upon the subscriber's location, there is still the possibility for data collisions, because there may also be administrative activity being carried out for that subscriber on the other node. A customer service representative may be

adding or modifying services for that subscriber. Alternatively, a batch job modifying a subscriber's record may be running on one node while the other node is processing that subscriber's cell phone traffic.

A data collision occurs if an administrative or batch action modifies a row in the database at one node at the same time that a cell phone transaction modifies the same row in the other node. If the data replication scheme replicates entire rows, the bi-directional replication of the changed rows will overwrite the changes first made at each node. Both databases are now different (inconsistent), and both are wrong.

To solve this problem, Shadowbase software uses *relative* replication rather than *absolute* row replication. If the change is numeric (such as adding five minutes to the subscriber's used time), his call time is incremented by five in the local database. Then, rather than sending the modified record to the other system, only the relative change to the numeric field is sent. In this case, the other system would be directed to add five to that data field for that subscriber. Therefore, only the relative changes are replicated if numeric changes are made to the same record, or even to the same data item, at the same time at two different nodes.

For instance, take the case of a data field that initially holds a count of 30 in both databases, as shown in Figure 2. Node A adds one to that data field at the same time that Node B adds eight to the field. Node A increments its data field to 31 and replicates a change of +1 to Node B. Node B adds 8 to the data field, resulting in a new count of 38, and replicates a change of +8 to Node A.

Upon receipt of the +1 directive from Node A, Node B increments its data field value from 38 to 39. Meanwhile, Node A adds 8 to its data field value of 31, resulting in a value of 39. Both nodes remain consistent and correct even though a data collision occurred.

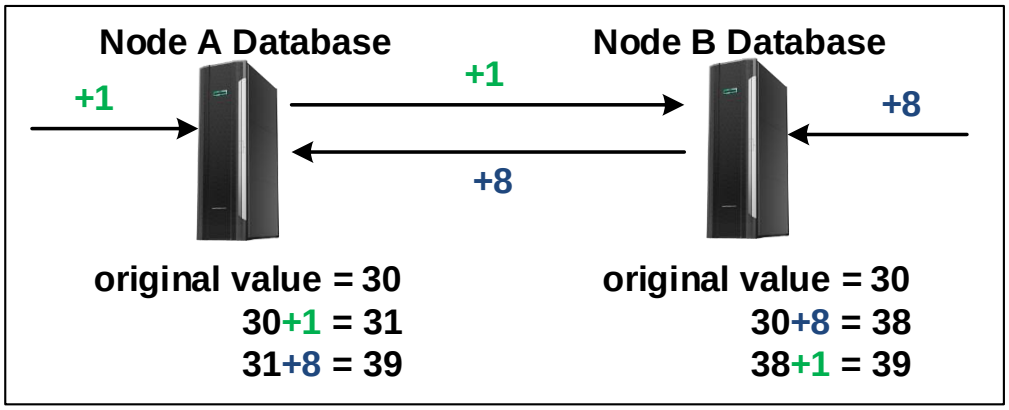


Figure 2 – Relative Replication

If a textual data collision occurs, the processing is not quite that simple. One or the other of the changes must be accepted and the other rejected. TIM has implemented a business rule that accepts the latest change. If Node A changes the text field in a row, and one millisecond later, Node B changes that same text field, Node B's change will overwrite Node A's change. This collision will be logged for later manual review and resolution.

Zero Downtime Migration

Telecom Italia plans to upgrade its INS systems to the latest versions of the NonStop operating system with no interruption to subscriber services, which will be done by switching all traffic to one node while upgrading the other node. Zero downtime migrations such as this are a hallmark of active/active systems since the traffic normally handled by a node can be switched to other nodes in the application network. That node can then be taken down for maintenance or upgrades. TIM's active/active configuration allows Telecom Italia to scale capacity by adding additional nodes to the TIM network and redistributing its cell tower traffic.

Summary

Telecom Italia is the leading provider of mobile phone services in Italy. Because of the critical nature of the mobile voice, text and data services it provides, Telecom Italia utilizes a pair of HPE NonStop servers located in different geographical areas and running in an active/active configuration. In this way, both servers can be used concurrently to handle customer calls and provide mobile services, but if one server becomes

unavailable, the other server can take over and maintain customer service without interruption (continuous availability). This configuration also allows one node to be taken out of service to perform planned maintenance, without the loss of mobile service to customers. None of these actions would be possible without the use of HPE Shadowbase bi-directional data replication software, which is used to keep the databases of the two servers synchronized (consistent and correct).

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

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