Enabling High Performance HLR Solutions

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Abstract

This paper highlights some of the strengths and capabilities of the ATCA platform by referring to Home Location Register (HLR), one of today's primary mobile telecommunications network applications. In the following sections, we will point out how ATCA solutions provide a high performance platform that addresses some of the key issues faced by HLR operators. This analysis is based on a study performed on Sun SPARC/Solaris-based ATCA computing blades, using Sun's robust, carrier grade middleware - Netra™ High Availability Suite, integrated with SolidTech's BoostEngine in-memory carrier grade database system. HLR scenarios were simulated using an OpenSource benchmarking tool called Telecom One (TM1) provisioned by Solid Tech. The study demonstrates how we achieved scalability, high performance and reliability.

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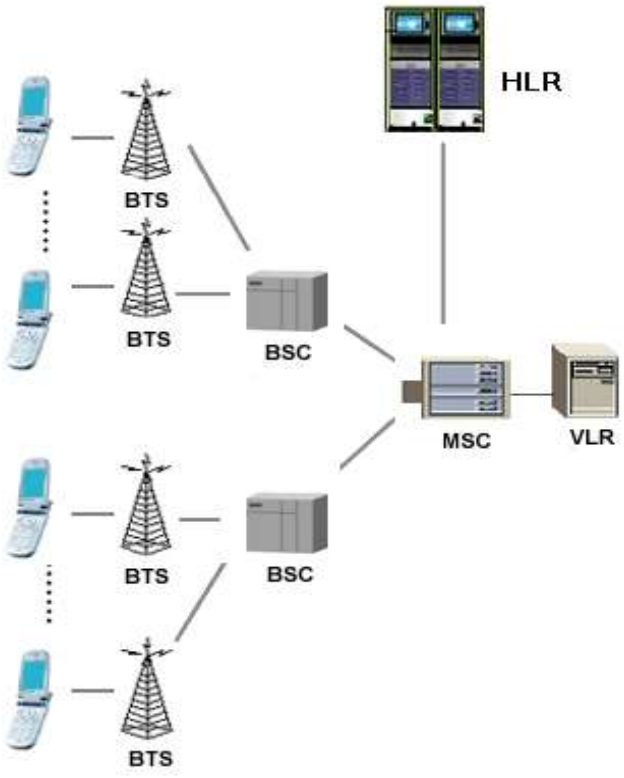
Introduction

Home Location Register (HLR)

Home Location Register is a database system in modern mobile networks that contains all the subscriber information. It applies to all types of mobile networks, such as CDMA, TDMA and GSM. The mobile network provider maintains this database system, which contains pertinent user information, including: address, account status, preferences, and especially, the subscribed services. The HLR interacts with the Mobile Switching Center (MSC), which is a switch used for call control and processing. The MSC also serves as a point-of-access to the Public Switched Telephone Network. The Visiting Location Register (VLR), which maintains temporary user information (such as current location) manages requests from subscribers who are out of the area covered by their home system.
When a user initiates a call, the switching equipment determines whether or not the call is coming from the device's home area. If the user is out of the home area, the area VLR sends out a request for information required to process the call.



An MSC queries the caller's HLR identified for information. The information is then relayed to the appropriate MSC, which in turn relays it to the VLR. The VLR then sends routing information back to the MSC, which allows the MSC to find the station where the call originated, and, finally, the mobile device to connect. Communications between the elements are based on Signaling System (SS7) protocols and signaling.

Issues and challenges with HLRs

- Performance: Need for fast lookups.
- Reliability: Fault tolerance.
- Scalability: Need for a distributed deployment.
- Versatility: Ability to handle various forms of networks.

Implementing HLRs on ATCA

Advanced Telecom Computing Architecture

Advanced Telecom Computing Architecture, popularly known as ATCA, is the largest specification effort in PICMG's history. ATCA belongs to the PICMG 3.x family and it is a new series of specifications, targeted at requirements for the next generation of carrier grade communications equipment. This series of specifications incorporates the latest trends in high speed interconnect technologies, next generation processors, and improved reliability, manageability and serviceability, resulting in a new blade (board) and chassis (shelf) form factor optimized for communications. ATCA provides standardized platform architecture for carrier grade telecommunication applications, with support for carrier grade features like high availability, reliability, redundancy and compliance with NEBS, ETSI.

Sun Microsystems' ATCA platforms

Sun Microsystems has developed a complete suite of ATCA system offerings, including compute blades based on UltraSPARC and Opteron family processors. The solution is housed in a 14-slot chassis with shelf manager (ShMM), shelf alarm panel (SAP) and dual-star PICMG 3.0, 3.1 compliant gigabit switches. There are three fan trays, air filter and redundant power entry modules. All of these components are individual, intelligent FRUs. The platform is capable to deliver a high availability of up to six nines (99.999999%) -- just seconds of downtime a year -- when deployed using a carrier grade operating system and Netra™ High Availability Suite Foundation Services. More information on these platforms can be found at: http://www.sun.com/atca

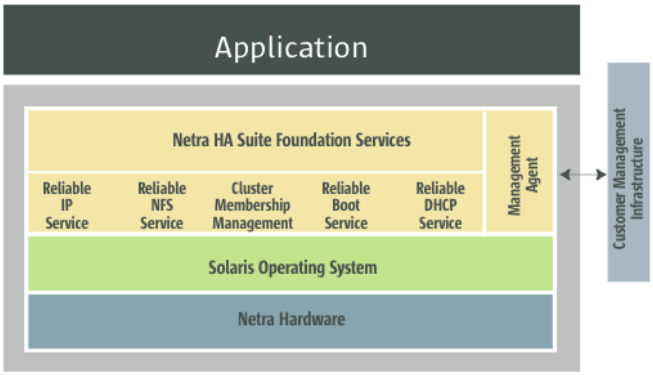
Netra™ CP3010 UltraSPARC ATCA Blade

Netra™ CP3010 is an ATCA UltraSPARC-IIIi-class computing blade that complies with the PICMG 3.0 and 3.1 specifications . The blade can be configured with up to two processors and 8GB memory. There are two 66/33MHz 64-bit capable PMC I/O slots, a compact flash slot, two RS232 serial interfaces, one SAS port, two 10/100/1000 Ethernet interfaces on base and two gigabit interfaces on extended fabric. The blade supports IMPI and e-keying features for manageability. There are two additional fast Ethernet ports available on the front for outbound, and out of the shelf management. An RTM with two corresponding PIM slots is also available.

In this study, we shall present our study based on dual-processor Netra™ CP3010 blades.

Netra™ High Availability Suite Foundation Services

This is Sun Microsystems' carrier grade high availability solution for Netra™ platforms. NHAS is designed for horizontal scalability (increase cluster performance by adding blades). NHAS consists of a Solaris HA container providing: cluster membership management (CMM), reliable NFS/network boot (RNFS), DHCP, and a system management agent. Recently, support for some Service Availability Forum (SAF) APIs has also been added. The goal of the SAF framework is to provide a uniform method



for managing deployment of software components within a cluster environment and to provide supporting services to preserve state and transactional integrity on node failover.

Solid Tech's In-Memory Database: BoostEngine™

Solid Tech's BoostEngine is a relational database management system. It combines a fully-transactional main memory engine and a powerful, disk-based engine into a single, compact and embedded database management system. Solid BoostEngine features a multithreaded main memory database engine, a disk based database engine and an advanced cost-based optimizer to maximize transaction performance. Tables that must provide immediate response time can be stored in memory, while, tables whose access time is less stringent or whose size is too large to reside in main memory economically can be stored on disk. Hence, hybrid data management is possible. In addition, Solid CarrierGrade™ option offers always-on, uninterrupted data access that provides up to six nines high availability (99.999999%).

Integration of Solid BoostEngine with Sun Netra™ HA Suite

Sun and SolidTech worked closely to integrate the BoostEngine database with platform middleware – specifically, Netra High Availability Suite. This was achieved by utilizing CMM (Cluster Management Module) APIs. In this integrated state, BoostEngine follows the cluster state as managed by the Netra HA Suite.

HLR simulation and performance

The Telecom One (TM1) Benchmark

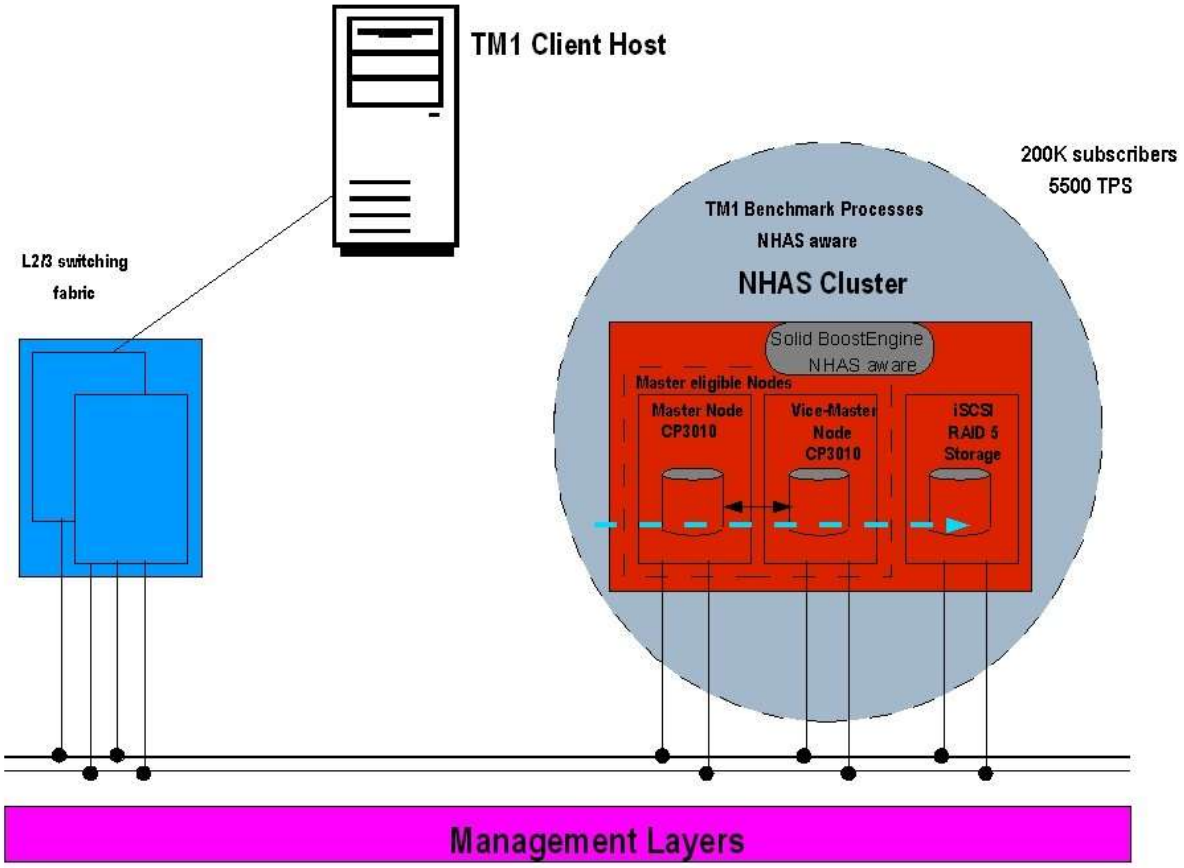
TM1 is the first database benchmark designed for telecommunication applications. It simulates a typical Home Location Register (HLR) database used by a mobile carrier. TM1 uses a technology stack composed of a relational database engine, operating system and hardware, and generates a measured database workload by issuing pre-defined transactions against a specified target database.
TM1 implements a test program that is used by a telecommunications equipment manufacturer to evaluate the applicability of various relational database implementations to support control programming in mobile networks. TM1 was published as part of a Master's Thesis at the University of Helsinki in 2003. More details about the origin of TM1 can be located at http://www.cs.helsinki.fi/u/tpstrand/thesis/.

The purpose of TM1 is to provide relevant and objective database performance information to telecommunications providers that can be used in capacity planning for new applications. It measures relative RDBMS, OS and hardware performance, and demonstrates performance differences between newer and older releases of RDBMS, OS and hardware.

Benchmark setup

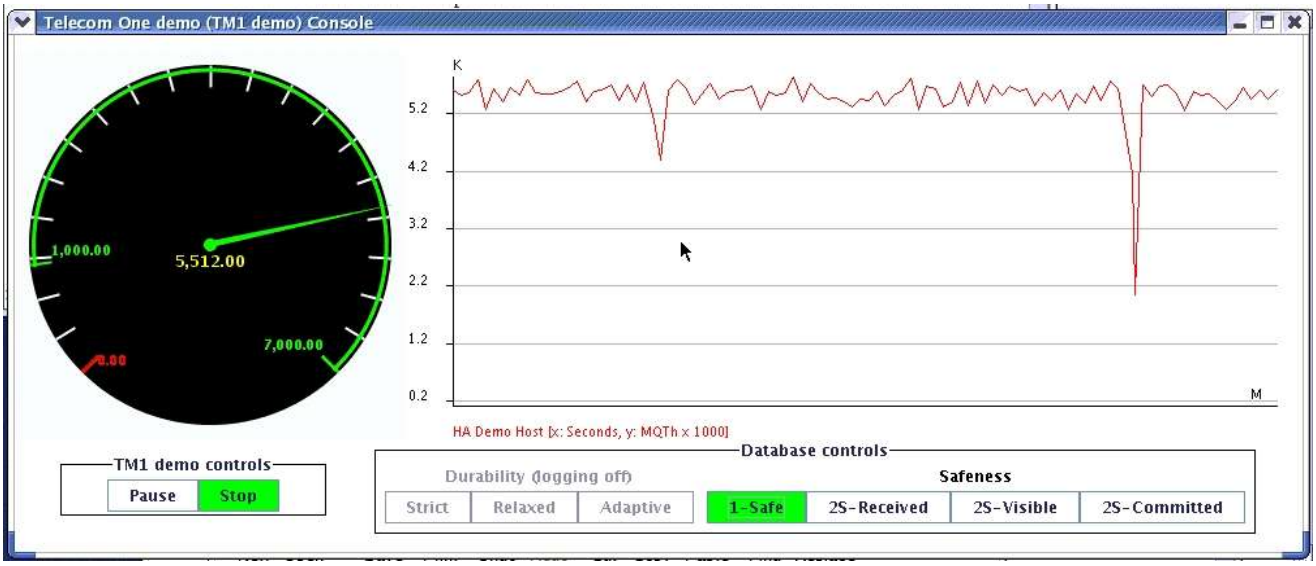
We used dual-processor Netra™ CP3010 blades in an ATCA shelf with the Solaris operating system. Netra HA Suite integrated with Solid BoostEngine 4.5 was configured to provide in memory databases. The TM1 benchmarking software tool was configured on a Sun V65x dual x86 processor system with Red Hat 9. Network interconnect was provided by ATCA base 3.0 Ethernet.

The TM1 schema consists of four interrelated tables. Before each benchmark run, the test database tables are populated according to strict rules for data granularity, distributions and integrity constraints. This ensures that each benchmark run begins with a consistent database population. The TM1 workload comprises seven, pre-defined transactions that insert, update, delete and query the data in the database with differing frequencies. 80% of the transactions are reads, 20% of them are writes. The sequence of transactions is randomized. The TM1 results show Mean Qualified Throughput (MQTh) of the target database system, and the response time distributions of transaction types for all seven types of transactions. For persistent storage of data, we used an Adtron iSCSI target within the ATCA shelf. This provides an integrated storage solution with reliability and performance. The volumes were configured with RAID5.



Benchmark test results on ATCA platform

The screen shot of benchmark test run results shows that approximately 5,500 transactions per second were executed against the test platform. The HLR dB was populated in memory with 200K subscribers. There are seven types of transactions in the test and they execute in a random fashion.
A slight drop towards the end of the graph was due to a failover performed on the clustered HLR, which was hosted on top of NHAS with master and standby nodes. This TM1 benchmarking tool was a customized version with HA awareness. The transaction rate was picked up immediately after a successful switchover to a second node.



Conclusion

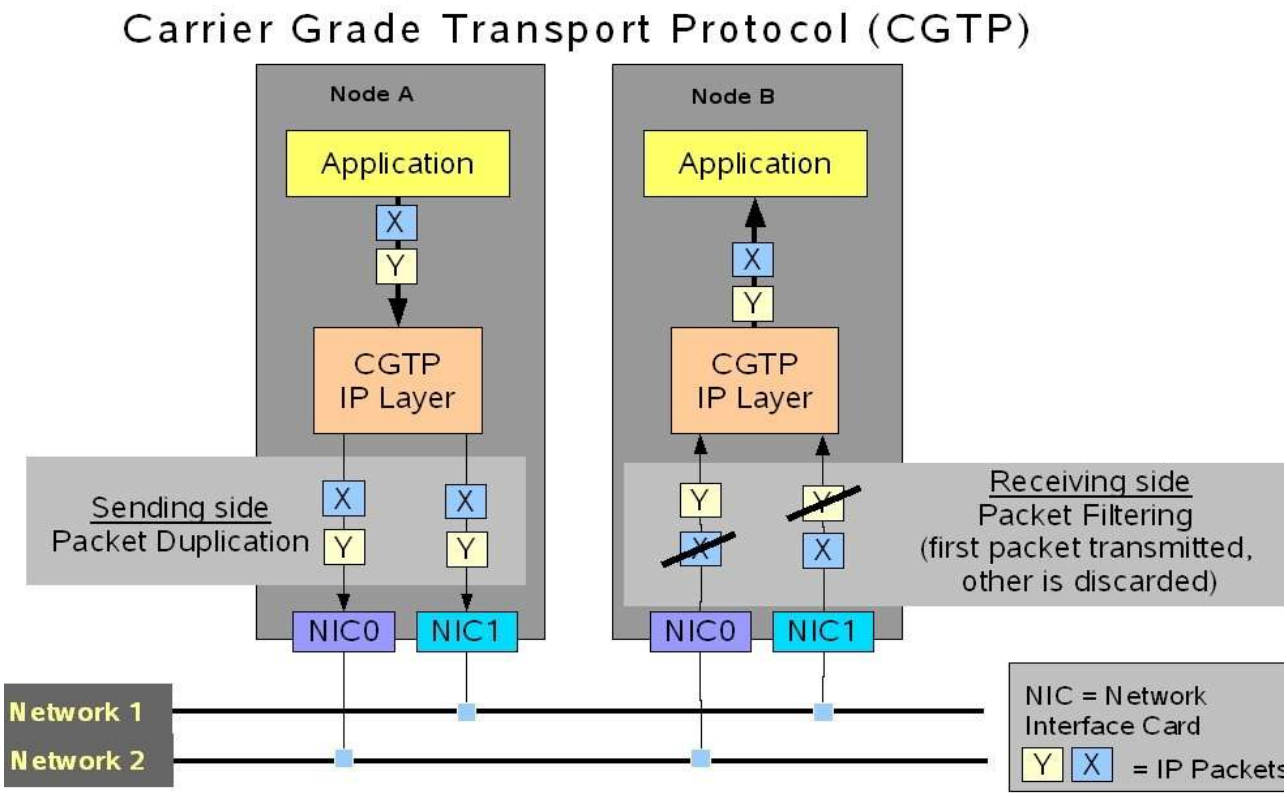
Sun ATCA solutions addressed the HLR challenges

Performance

As evident from the results shown above, we achieved 5,500 transactions per second on the simulated HLR running on dual-processor Netra™ CP3010 blades, with Solaris and Netra HA Suite integrated with Solid BoostEngine. This performance was consistent over the full, 12 hour test run. The database was populated with 200K subscribers.

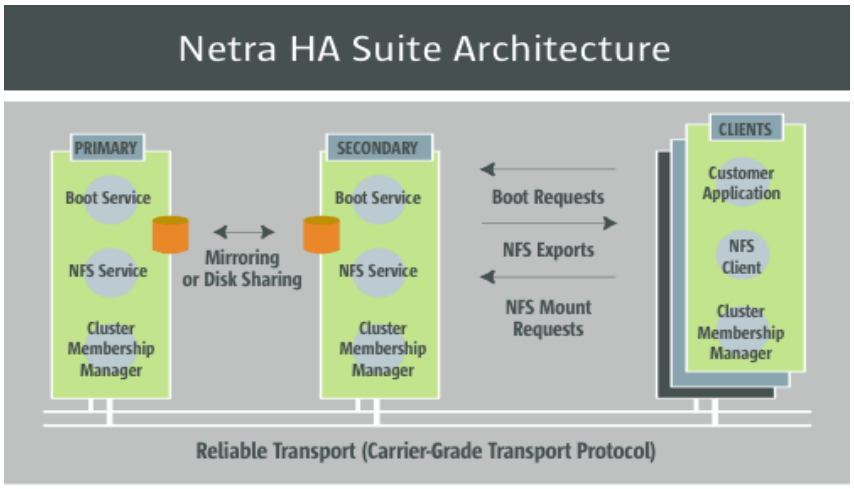
Reliability

The solution uses an ATCA core architecture supporting Carrier Grade
Transport Protocol (CGTP) standards, SAF compliant Netra HA Suite middleware, with features like CMM, and an
integrated, in-memory database engine with cluster control. In the unforeseen event of any single network, board, disk or switch failure, services remain available at all times. Netra HA suite controls and manages the cluster memberships. The configuration can be set to operate under N+2 nodes.



Scalability

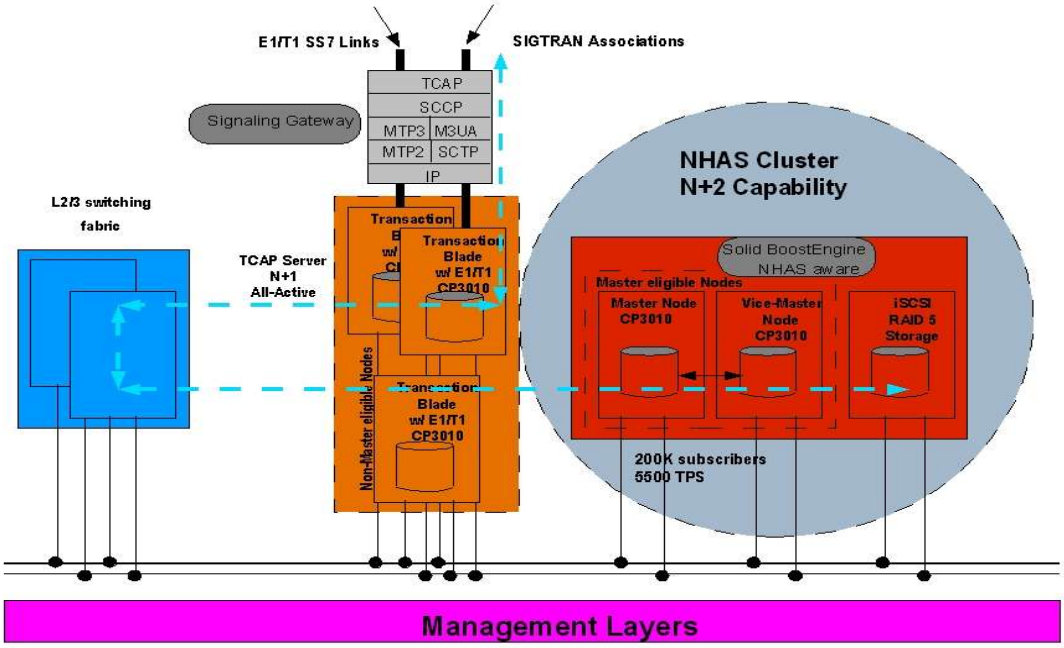
Sun's ATCA shelf is a 14-slot platform that can host twelve computing nodes. All of the nodes are managed
within a shelf using reliable IPMI interfaces. Netra HA Suite middleware provides a SAF compliant layer, to cluster these nodes together and function as a single platform.



Netra HA Suite : N + 2 configuration

Versatility

ATCA is an open architecture and many NEPs have developed ATCA compatible I/O solutions. Sun has been aggressively adapting this open technology and building an echo system with these NEPs, to allow connectivity to all modern telecommunication architectures. The current PMC I/O slots can be



expanded to connect to SCSI, Fibre channel HBA, T1/E1, SS7, ATM, Gigabit as well as 10Gigabit networks. The illustration below shows how an ATCA platform can be used for SS7 and Signaling Gateway applications in conjunction with HLR implementation in a cluster mode.

This study's results in: Performance, Reliability, Scalability, and Versatility demonstrate how a new breed of AdvancedTCA blade server, utilizing UltraSPARC-IIIi processors, from Sun Microsystems, can effectively address some of the common challenges of HLR/HSS. Sun's SPARC ATCA platform not only delivers high performance, but also maintains carrier grade, six nines availability and reliability through Netra HA Suite and the Solaris operating system. Solid Tech's BoostEngine software runs off a small footprint, and its rich, carrier grade features make it an ideal solution for such an environment.

Glossary

ATCA	Advanced Telecom Computing Architecture
BSC	Base Station Controller
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CGTP	Carrier Grade Transport Protocol
DB	Database
GSM	Global System for Mobile Communications
HA	High Availability
HBA	Host Bus Adapter
HLR	Home Location Register
iSCSI	Internet SCSI (Small Computer System Interface)
MSC	Mobile Switching Center
MQTh	Mean Qualified Throughput
NHAS	Netra High Availability Suite
PSTN	Public Switching Telephone Network
PICMG	PCI Computer Manufacturers' Group
RNFS	Reliable Network File System
SAF	Service Availability Forum
SAP	Shelf Alarm Panel
ShMM	Shelf Management Module
SS7	Signalling System #7
TDMA	Time Division Multiple Access
TM1	Telecom One
VLR	Visitor Location Register
VOIP	Voice over Internet Protocol

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http://www.adtron.com/

