

Sun Fire™ X4450 and Sun Fire™ X4150 Servers
Sun Netra™ X4450 and Sun Netra™ X4250 Servers
Synapse Mobile Networks Active Device Management System (ADMS)
Intel® Multi-Core Technology and Intel® Solid State Drive

Improving the User Experience and Reducing Customer Care Costs via Mobile Device Management

Executive Summary

Synapse Mobile Networks is one of the leading suppliers of mobile device management solutions with over 135 installations world-wide. Synapse ported its Active Device Management System (ADMS) application to an Intel® architecture-based 64-bit Server platform using Intel® High Performance SATA Solid-State Drives (SSD) and running the Sun® Solaris™ operating system. This was a straight-forward code migration that required some driver modifications, no application code changes and produced a prototype within a week.



synapse
mobile networks



Simplifying Mobile Device Configuration

Mobile devices are getting more and more sophisticated as new services are being introduced in Mobile Networks. In response to this increasing complexity, there's a growing urgency to solve device configuration problems before they become support issues and burden already resource constrained customer care service departments. This is where the Active Device Management System (ADMS) from Synapse Mobile Networks plays an important role. The ADMS is connected to the mobile network and runs a real-time database of all subscribers and their mobile devices. When a subscriber attaches to the network with a new device, the ADMS immediately updates its database and automatically sends the configuration, which corresponds to the device's capabilities and the subscriber's profile. This approach solves the problem of configuring sophisticated devices and resolves issues that otherwise would burden customer care operations. Such a network is illustrated in Figure 1, which shows how the ADMS interfaces to other wireless network elements and service provider systems like billing and contract administration services.

The driving factors behind mobile operators adopting device management systems, besides solving the technical problems around device configuration, are increasing revenue by enabling non-voice services and reducing costs for customer care calls. The introduction of 3G and HSDPA technologies has increased data speeds as well as capacity in mobile networks, and mobile operators want to capitalize on their investments by introducing additional data services to their subscribers.

Helping achieve these objectives, an ADMS enables the delivery of the right service to every mobile device and individual user, resulting in a quicker uptake and increased revenue from data services. In contrast, manually configuring devices for data services is very cumbersome, often requiring multiple steps that involve complicated device menus. Device configuration support phone calls are typically lengthy and can consume as much as 50 percent of a mobile operator's total cost for customer care services. These costs can be substantially reduced by introducing a system that automatically configures user devices over-the-air.

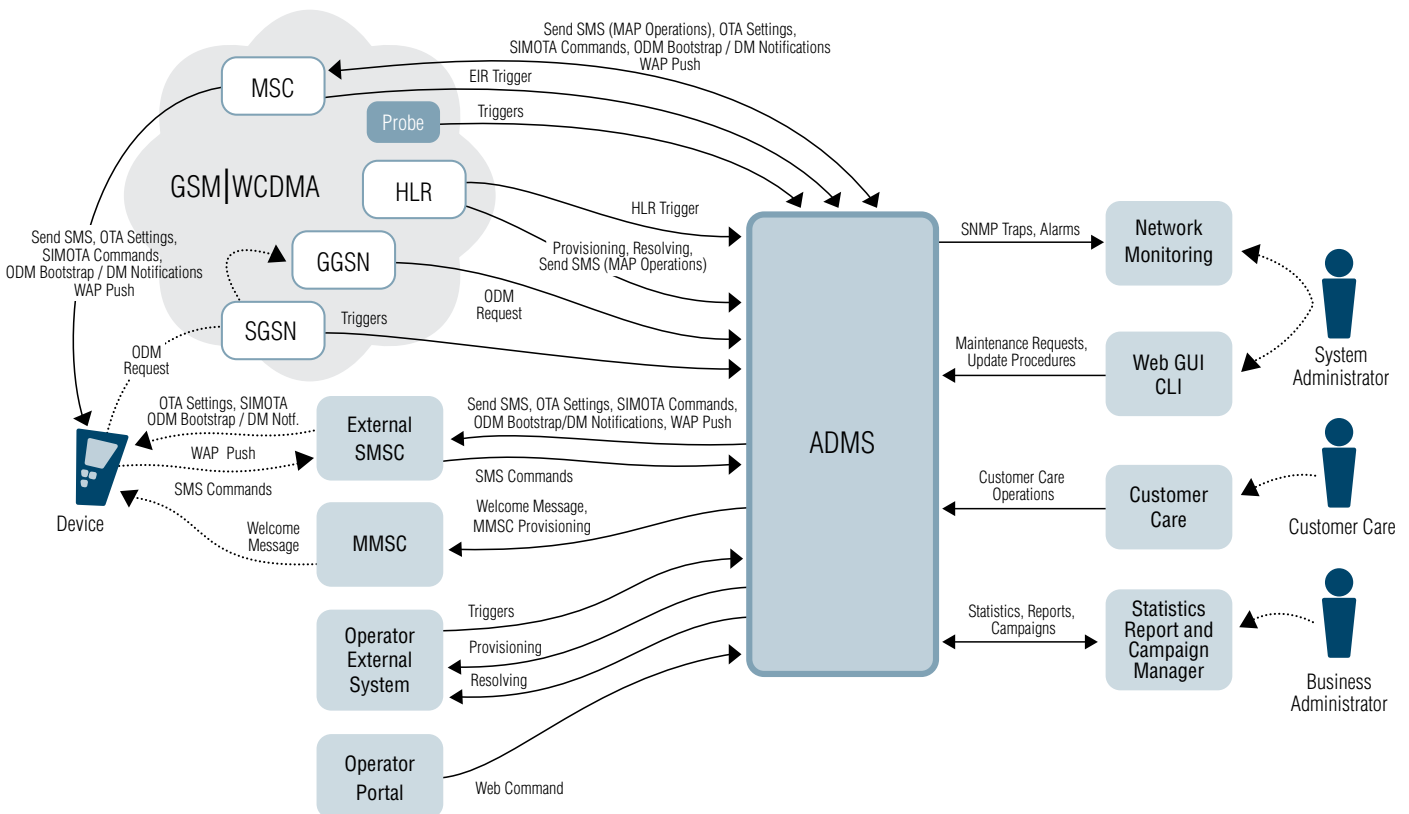


Figure 1. ADMS in a Mobile Network

For the end-user, automatic device management is all about making services work. Most usability research indicates that users try to make services work once or twice and then they give up and never try again. ADMS on the other hand makes services work instantly and in a non-intrusive way for the end-user. Deploying automatic device management solutions creates a win-win situation both for mobile operators and their customer base.

An application, such as ADMS, combines very high real-time requirements on mobile network connectivity with the demand for instant access to large subscriber databases. Every time a subscriber attaches to the mobile network, signaling events are sent to the ADMS, which may hold up to 100 million mobile subscriber records for large installations. A subscriber may purchase a new phone anywhere in a Mobile Network (country) so it's preferable to keep all of the subscriber records in a single view (system). The challenge is to build a system platform that can simultaneously satisfy very high real-time processing requirements and provide instant access to vast amounts of subscriber information stored in multiple databases. The platform must process small data records at very high frequency, and this requires the integration of leading-edge software, server and disk technology.

This solution brief provides the results of an ADMS migration, illustrating how mobile operators can achieve optimal performance and the low cost of ownership by deploying automatic device management solutions on the latest server and solid state drive technology.

Identifying Millions of Subscribers

Synapse's Active Device Management System (ADMS) is an important node in a mobile operator's network. It is responsible for detecting new mobile subscribers and phone combinations while keeping a real-time database of all existing mobile subscribers and their respective phones. The ADMS connects to the network signaling and detects whenever a subscriber attaches to the mobile network by capturing the following information:

1. International Mobile Equipment Identity (IMEI) device serial number
2. International Mobile Subscriber Identity (IMSI)
3. Mobile Subscriber ISDN Number (MSISDN)

Subscriber identification requires several time-critical database operations while thousands of subscribers are attaching every second and 20 to 100 million subscriber records are stored in ADMS databases – for large mobile operator networks. An ADMS is deployed by mobile operators who are looking for dense and energy-efficient solutions that can support more subscribers and services.

In order to optimize the ADMS performance, Synapse is adopting the latest server platforms featuring multi-core processors and solid state drives, which provide opportunities to increase system processing as well as database access performance. Adding cores to processors can significantly boost computing performance with little or no increase in power consumption. Adding solid state drives further improves database access performance and significantly increases the subscriber database capacity handling in the ADMS.

Migrating the Platform

Synapse's Active Device Management System (ADMS) code base runs on the Solaris operating system, which has a strong reputation for reliability, scalability and service. However, the performance of the former platform was failing to scale and handle mobile networks above 20 million subscribers



Figure 2. Sun Fire™ 4450

while keeping a single system view. The challenge was to port the application to a higher performance platform that would preserve the code base, thereby maintaining the high quality and availability of the system. Synapse decided on Sun Fire™ servers that are equipped with powerful Intel® Xeon® processors with quad-core technology running the Solaris operating system.

Synapse Ports to Sun Fire Servers

As part of selling turn-key solutions to mobile operators, Synapse is responsible for platform architecture decisions, including the choice of server platform. Their server selection process benchmarks compute performance and application porting effort. Sun Fire servers delivered on both, providing five times greater performance than the prior platform and requiring only one week to port the application. The combination of Sun Solaris and Intel® Architecture Processors is consistent with Synapse's platform strategy of deploying one of the best of breed commercial off-the-shelf hardware and operating system platforms to enable the low cost of ownership.

ADMS performance depends on processing out-of-band signaling transactions quickly – signaling system number 7 (SS7) – and accessing an internal database that contains all mobile subscribers and their respective handsets. The information retrieved from the database is analyzed against existing subscriber information, and a change in a subscriber's handset model is written to the database. Further action may be taken depending on the subscriber profile and the handset capabilities. The performance of the ADMS is indicated by its combined signaling and database handling capacity.

It was relatively easy for Synapse to port their ADMS application to Sun Fire Servers, and the migration to solid state drives required no software change at all. The ADMS software was recompiled, but no application code changes were required. In rebuilding their software platform for Intel Xeon processors, Synapse used the GNU Compiler Collection* (GCC) for compilation and the Sun Solaris Runtime Linker. Since the majority of the application is written in Erlang, a byte compiled language, the software porting effort was concentrated in the following areas:

Erlang* Virtual Machine (VM)

Erlang* is an open-source, general-purpose programming language and runtime environment with built-in support for concurrency, distribution, fault tolerance and incremental code loading. Since the Erlang VM already ran on Intel platforms, the majority of the effort was verifying some Synapse-specific features.

Oracle* Berkeley Database (DB)

The Oracle* Berkeley DB family of open source, embeddable databases provides developers with fast, reliable, local persistence with zero administration. Often deployed as “edge” databases, the Oracle Berkeley DB family provides very high performance, reliability, scalability and availability for application use cases that do not require SQL. Again, since the Berkeley DB is widely used on Intel® platforms, this was primarily a verification task.

Erlang* Linked-In Drivers

Similar to device drivers, the Synapse EIR platform has linked-in drivers to provide high-performance interfaces to the database and SS7 subsystems. This porting required some additional work due to the little-endian format (byte ordering) of the Intel® processors.

SS7 Device Drivers

New Intel architecture/Solaris drivers, which were provided by the hardware vendor, required verification.

“After a successful and minimal effort porting to servers powered by Intel® Xeon® processors and Intel® Solid State Drive, the ADMS from Synapse delivers outstanding system performance.” The system database access improved a hundred times, and at the same time the subscriber database capacity doubled to 40 million subscribers on an entry-level system. The system footprint was reduced by 75 percent and the energy consumption was reduced by 50 percent,” says Per Bergqvist, CEO of Synapse Mobile Networks.

Lessons Learned

Synapse was impressed with the relative ease of porting their Solaris-based ADMS application to a higher performance platform with the specific aim to scale the system capacity in large mobile operator networks. The porting process was straightforward because Sun has maintained binary compatibility between operating system releases for nearly a decade, enabling existing Solaris applications to run unmodified on Solaris 10. This means that Solaris applications developed ten years ago will run unchanged on Solaris 10, taking full advantage of new and advanced Solaris features. With Solaris

10, Sun now guarantees source code compatibility between SPARC and Intel Xeon processors, ensuring applications can run across platforms with a simple recompile.

With Solaris source code compatibility, it's easier to benefit from a combination of Sun's experience in telecom and Intel's energy-efficient microprocessor technology. Equipment makers and mobile operators can make a smooth transition to a higher performance system while preserving their code base. And by selecting standards-based Intel architecture, developers have a wide choice of vendors for components and subsystems, with the advantage of competitive pricing and interoperability. This flexibility extends to both enterprise class and carrier grade servers from Sun.

Added Benefits from Solaris

The Solaris 10 Operating System integrates a number of high availability and storage system features that can simplify system administration and eliminate the need to acquire some storage management components separately. It has built-in features that can help increase availability of an ADMS such as predictive self-healing operations. This technology enables systems to accurately predict component failures and mitigate many serious problems before they actually occur. This fault management technology includes the following capabilities:

- **Auto Diagnosis and Recovery:** automatically detects, diagnoses and isolates faulty or suspect components for faster time to service, which can virtually eliminate downtime.
- **Persistent CPU Offlining:** allows the system to restore availability by configuring itself around the failed component(s) during a reboot.
- **Memory Page Retirement:** helps enable the system to detect potential memory chip failures and automatically migrates data from a suspect memory address range.
- **Predictive Self Healing:** takes faulty components offline after detecting and diagnosing underlying problems associated with hardware and software errors collected by the Solaris Fault Manager.

An ADMS incorporates large internal or external storage devices that maintain large databases. Solaris includes capabilities that simplify storage management such as ZFS and RAID-Z (similar to RAID-5). ZFS is a free, open-source file system that does away with many complicated storage administration concepts and automates many common administrative tasks, including:

- **Powerful, Single Commands:** reduce the effort to create/grow storage pools and add/remove file systems, which is a significant improvement over traditional file systems and volume managers that often require system administrators to use tedious multi-step processes.
- **File System/Volume Manager Model:** eliminates the need for volume manager software, disk striping and mirroring and eases administration by removing the constraints associated with directories and subdirectories, letting administrators virtualize disks and manage data across physical volumes.
- **New Data Replication Model (RAID-Z):** uses variable stripe width to eliminate write holes that can occur when a loss of power occurs between data and parity updates.

Solaris also supports Dynamic Tracing (DTrace), a framework for troubleshooting systemic problems in real time on production systems. DTrace is designed to quickly identify the root cause of system performance problems. It safely and dynamically instruments the running operating system kernel and applications without rebooting the kernel and recompiling - or even restarting - applications. DTrace can be used to visually monitor performance on a per CPU core basis and track down performance bottlenecks. This can help system administrators and developers identify the reasons for suboptimal system and application performance.

Servers Deliver Performance, Density and Energy Efficiency

Targeting dense data centers, Sun developed a chassis that optimizes cooling and power efficiency and offers industry-leading energy efficiency and performance in a small form factor. The result is a 2 rack mount unit (2RU) server platform that supports up to four processors (16-CPU cores), 128 gigabyte of memory and over one terabyte of internal storage. Based on this platform, the Sun Fire X4450 and Sun Fire X4150 servers can be used for horizontal database and other disk-intensive applications. The Sun Fire X4450 offers up to twice the compute power and memory capacity, and as much as 50 percent lower energy consumption as competitive servers, resulting in reduced energy and cooling costs. This industry-leading performance density allows operators to do more with less equipment.



Sun Netra X4250 Carrier-Grade Server

Like all Sun Fire servers, the Sun Fire X4450 server is designed with redundant and hot-swappable components, such as cooling fans, power supplies and disk drives, that simplify component replacement.

Carrier-Grade Server Solutions

When equipment manufacturers require carrier grade solutions, they should consider Sun Netra X4450 and X4250 servers that incorporate the same hardware and software technologies as Sun Fire servers. The Netra platforms have the performance headroom needed for consolidation and virtualization in a 4RU or 2RU footprint.

These servers, which extend the platform choice for Sun's Solaris 10 Operating Environment, are well accepted by network carriers worldwide and maintain carrier class reliability. Equipment makers and mobile operators who want a universal

platform – spanning across different applications – will find Sun Fire servers offer a high degree of I/O, memory and storage flexibility. They deliver performance headroom, powered by Intel Xeon processors with quad-core technology, and run multiple operating systems and virtualization software including Solaris OS, Linux*, Windows* and VMware*. Likewise, carrier grade servers, such as the Netra X4450 and x4150, support these capabilities.

Servers Delivered with Solid State Drive

Exchanging Sun Fire server internal hard disks with the Intel® X25-E SATA Solid-State Drive, the Sun Fire server with Intel X25-E SSD significantly improves I/O capacity and nearly eliminates I/O bottlenecks in the ADMS. The combination of Intel X25-E SATA Solid-State Drive, pictured in Figure 3, and the ZFS file system provides a reliable self-healing high performance storage platform.

The ADMS is an I/O intensive system that handles and stores thousands of incoming events per second, which are randomly distributed in a database with 100 million entries or more. By replacing the conventional rotational hard drives with Intel SSDs, the ADMS has rebalanced the level between I/O and CPU capacity. It's possible to replace up to fifty high-RPM hard disk drives with one Intel X25-E Extreme SATA Solid-State Drive and handle the same computing workload while using less space and power.



Figure 3. Intel® X25-E SATA Solid-State Drive

This improved I/O capacity directly translates into significant space, power and cost savings.

A complete high-end system can now be delivered in only

two rack units, compared to six rack units required with more expensive and lower-performing external disk arrays.

Another major benefit of using Sun Fire X4150/X4450 servers with Intel SSDs is the decreased system complexity. Fewer components to manage can lead to lower operational costs. From a system architecture perspective, it's possible to reduce cache and intermediate data handling, thereby further improving the robustness of the system.

Compute Density Multiplies

The latest Intel® multi-core processors, based on the Intel® Core™ microarchitecture, provide high performance and greater energy efficiency, resulting in better performance per watt. The Intel® Xeon® processor 5300 series with quad-core technology doubles the compute density over previous Intel Xeon processors with dual-core technology and delivers three times greater performance per watt in the same power envelope¹.

Embedded Intel Xeon processors, with extended lifecycle support, provide breakthrough performance and energy efficiency for compute-intensive embedded, storage and communications platforms. These CPUs and associated chipsets support high I/O bandwidth and are ready for 10 Gigabit networks.

Denser and More Energy-Efficient Infrastructure

It's easier than ever for mobile operators to boost the performance of Solaris-based applications by migrating them to energy-efficient servers based on Intel multi-core processors. These platforms also benefit from open architecture, which promotes a wide range of commercial off-the-shelf hardware and software building blocks. This helps lower hardware and software costs, which can increase service providers' margins. With the relatively easy migration of applications on Solaris, operators can deploy the latest infrastructure technology faster and lower the cost of bringing new services on-line.

Additional information about these products and solutions can be found at:

<http://www.synap.se/>

<http://www.sun.com/servers/x64/x4250/>

<http://www.sun.com/servers/x64/x4450/>

<http://www.sun.com/netra/X4250>

<http://www.sun.com/netra/X4450>

<http://developer.intel.com/products/embedded/index.htm>

<http://www.intel.com/design/flash/nand/extreme/?iid=SEARCH>

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