

Upgrading a Telecom Billing System with Intel® Xeon® Processors

Migrating from a legacy RISC platform to a server platform powered by Intel® Xeon® processors has helped Yunnan Telecom meet its goals for cost-effectiveness, energy efficiency, and flexibility and gain an edge in the competitive telecom industry



EXECUTIVE SUMMARY

In the second half of 2011, Intel and AsialInfo Linkage helped Yunnan Telecom perform verification testing to determine the feasibility of deploying Intel® Xeon® processor-based servers in a production environment for the provincial telecommunications billing system.

The test had two parts: the billing applications and billing database. Test results proved that the Intel Xeon processor-based servers both met the provincial telecommunications billing system's requirements and outperformed the legacy RISC platform. After the test was completed, both the billing application and the billing database based on the Intel Xeon processor had been officially put into the production environment.

For the tests described in this paper, the Intel platform-based servers took over about 30 percent of the RISC-based production database's workload. Analyzing performance data through a full billing cycle showed that by offloading just that portion of the workload, the server's CPU and memory usage remained low, with system effectiveness increasing by about three to five times and total cost of ownership (TCO) dropping by nearly 60 percent over the RISC-based system.

This paper explains how using this migration approach and the latest technologies from Intel can make today's telecommunications business and operation support systems (B/OSS) cost effective while providing energy efficiency, stability, and flexibility in the way the billing systems work. Using the latest technologies can help telecommunications companies become more competitive.

Building a Competitive Edge

For years, the telecommunications industry has widely used RISC, with its high performance and unparalleled stability, as the platform of choice for B/OSS. As the telecommunications industry became increasingly competitive, carriers' business models gradually transitioned from a traditional resource-based model to a user-based model. This transition has made the B/OSS increasingly important, prompting major telecommunications companies to invest heavily in continuously upgrading and expanding their platforms to keep up with both marketplace demands and the competition.

The closed nature of the RISC platform has made acquisition and maintenance costs high. The comparably long delivery cycles also made RISC unsuitable for quickly meeting new businesses demands. With such drawbacks, the RISC platform hasn't been able to keep up with the pace of development in telecommunications B/OSS systems.

At same time, the Intel Xeon processor has matured greatly, especially with breakthroughs by the Intel Xeon processor E5 and E7 families, which offer better overall system performance, scalability, and lower power use and deliver increased RAS capabilities. The latest generation of Intel Xeon processor can now rival the RISC platform for performance and stability.

More users have begun to use the Intel Xeon processor in mission-critical areas, significantly lowering total cost of ownership (TCO) of the system while improving performance and stability. In telecommunications, the world's major carriers have also begun to deploy Intel Xeon processor-based servers in different areas in their B/OSS systems to improve cost-effectiveness, energy efficiency, and flexibility.

With this backdrop, Yunnan Telecom, Intel (China), and AsialInfo Linkage decided to collaborate on testing the deployment of Intel Xeon processor-based servers in a telecommunications billing system. They had four objectives:

1. Perform extensive feasibility and proof of concept (PoC) testing of its B/OSS system migrated to servers with the Intel Xeon processor.
2. Deploy Intel Xeon processor-based servers for the billing application and database system in parallel with the existing RISC-based billing system. Evaluate how the billing workload can be effectively and efficiently balanced between Intel Xeon processor-based servers and the existing RISC-based billing systems.

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3. Test and review operational monitoring data and optimize the performance of the Intel Xeon processor-based servers, Linux operating systems, and database in the production environments. Create and document best practice reference materials.
4. Review and optimize Intel’s standard RISC migration procedure as required to reflect the in-depth learnings gained from migrating the telecommunications company B/OSS system.

Verification Testing

Test Plan

To develop the migration plan, Yunnan Telecom wanted to test for efficiency in four areas:

1. Migration plan
2. Data migration
3. Inquiry requests
4. Storage system

Figure 1 shows the test plan topology.

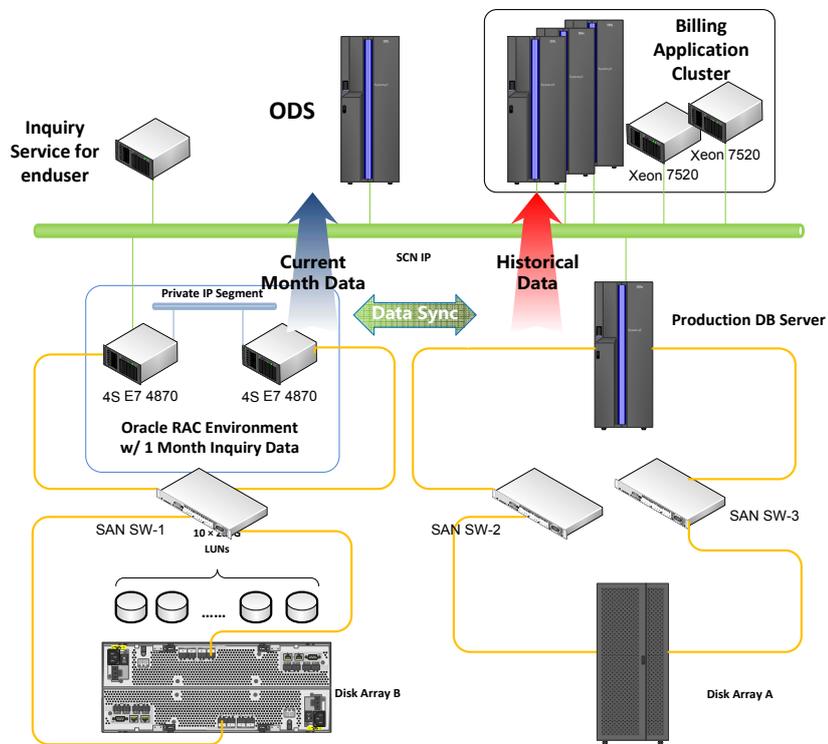


Figure 1. Test Plan Topology

Migration Plan

Yunnan Telecom’s billing system uses a system architecture with three layers:

1. Presentation layer
2. Application layer
3. Data layer

The application and presentation layers are deployed in the billing application cluster, while the data layer is deployed separately on the database server.

Since the migration test uses the parallel model to share the workload of the existing system, both systems have the same physical architecture. For the testing, two newly-installed Intel Xeon processor 7520 series-based servers were deployed with the same application server software as the production systems. These were added into the existing cluster of billing applications as new nodes. The other two newly-installed Intel Xeon processor E7 4870 family-based servers were deployed into Oracle RAC* environments, since the billing inquiry database (inquiry database) works in parallel with the existing database system (production database).

Data Migration

Since the Intel® architecture system would work in parallel to take over the billing inquiry function, AsialInfo Linkage modified the original storage program so that it could asynchronously and simultaneously write data into the inquiry and production databases. Tests measured the maximum delay of the asynchronous input, which should not be more than three minutes (an acceptable time for billing inquiries).

Inquiry Requests

After migration, the system will handle billing inquiries from three main sources:

1. Requests for billing details. Provide inquiry services to telecom business office clerks.
2. Inquiries about bills. Provide inquiry services to call center agents and online business users.
3. Inquiries from the operational data store (ODS): Provide details on the bills to the ODS system.

Storage System

After migration, the inquiry database is not connected to the production database disk array. Instead, it uses a backup disk array. By separating the billing data in the inquiry database on different storage systems that run in parallel, it can easily become the backup system, or even the disaster recovery system, for the production database in the future.

Phase-Based Testing Plan

Since the objective of the migration is to deploy the Intel Xeon processor-based billing system into production, it was essential to test the system in the actual production environment to avoid any adverse impact. The comprehensive tests were carried out in two phases:

- Phase I. Add two Intel Xeon processor 7520 in the billing application cluster with WebLogic* and Tuxedo* deployed. Add these to the cluster as new nodes. After that, complete step-by-step verification testing on the performance and stability of the Installed servers. (Both offline and online test trial runs were successfully completed in August of 2011 and the Intel billing application system was formally launched.)
- Phase II. Add two Intel Xeon processor E7 4870-based servers to the original billing system and deploy the Oracle RAC environment. By importing parts of the database table, the servers are able to take over a portion of the workload from the production database. After that, complete step-by-step verification testing on the performance and stability of the Intel architecture-based servers in the billing database environment and online operation. (Offline and online test trial runs were successfully completed in November 2011 and the Intel architecture-based inquiry database was formally launched.)

Testing Platforms

Table 1 shows the software and hardware used in this migration.

Table 1. Testing Software and Hardware

| Platform | Billing Application | Inquiry database |
|------------------|--------------------------------------|------------------------------------|
| CPU | Four Intel Xeon processors 7520 | Four Intel Xeon processors E7 4870 |
| RAM | 128GB | 256GB |
| Operating System | RHEL* 5.5 | RHEL 5.6 |
| Middleware | WebLogic for Linux, Tuxedo for Linux | N/A |
| Database | N/A | Oracle* 11g R2 for Linux |

Testing Results

Billing Application System Testing

Application system testing compared the differences in performance between the Intel architecture-based server and the legacy RISC server while using the same backend database. Figure 2 shows the test environment. Table 2 shows the billing application system test results.

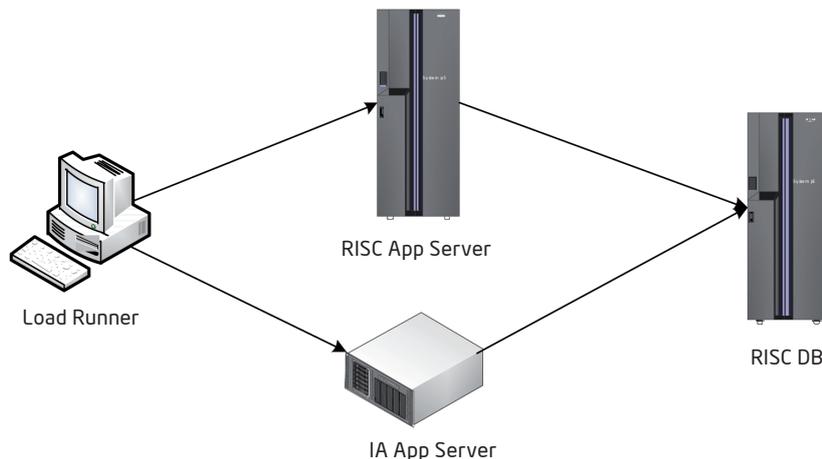


Figure 2. Billing Application System Test Environment

Table 2. Billing Application System Test Results

| | Comprehensive Inquiry | | Phone list | | Phone bill | |
|------------------------|-----------------------|---------------|------------|---------------|------------|---------------|
| | TPS | Response Time | TPS | Response Time | TPS | Response Time |
| Intel Architecture | 6.013 | 1.18 | 10.35 | 0.765 | 65.421 | 0.12 |
| RISC | 2.751 | 2.402 | 6.146 | 1.05 | 2.526 | 3.12 |
| Performance comparison | 218.6% | 203.6% | 168.4% | 137.3% | 2589.9% | 2600.0% |

The test data shows that the Intel architecture-based server’s performance is much better than the legacy RISC servers under the billing application system environment.

Database Testing

Database testing compares the differences in performance between the Intel architecture-based database server and the legacy RISC database server while using the same application system platform. Figure 3 shows the test environment. Table 3 shows database test results and Table 4 shows performance parameters.

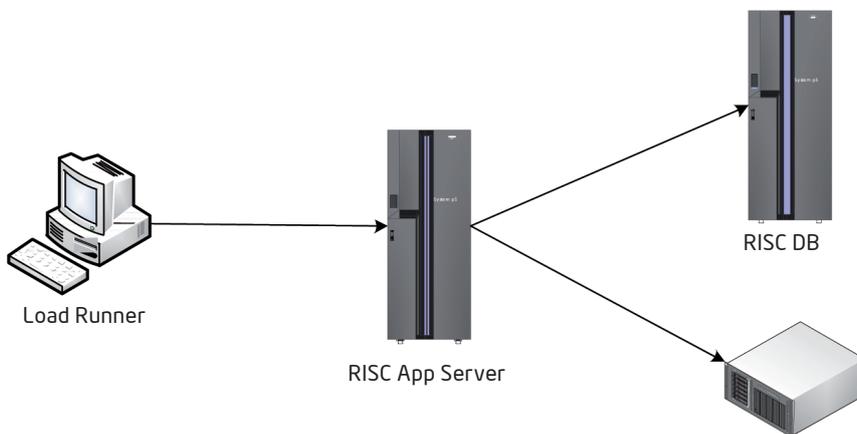


Table 3. Database Test Results

| Intel Architecture Database Stress Test Data | Real-Time Bill (Voice) | | Real-Time Bill (Data) | | Real-Time Bill (CDMA1x) | |
|--|------------------------|---------------|-----------------------|---------------|-------------------------|---------------|
| | TPS | Response Time | TPS | Response Time | TPS | Response Time |
| 20 v-users | 2.1 | 8.4 | 10.2 | 1.9 | 7.3 | 2.2 |
| 40 v-users | 3.7 | 9.3 | 18.9 | 2.2 | 12.3 | 2.3 |
| 60 v-users | 5.6 | 10.8 | 25.6 | 2.5 | 16.1 | 2.4 |

Table 4. Database Performance Parameters

| Performance Parameters During Normal Operation of the Production Library | Real-Time Bill (Voice) | | Real-Time Bill (Data) | | Real-Time Bill (CDMA1x) | |
|--|------------------------|---------------|-----------------------|---------------|-------------------------|---------------|
| | TPS | Response Time | TPS | Response Time | TPS | Response Time |
| 2 v-users | 0.39 | 6.2 | 1.77 | 1.4 | 0.66 | 2.33 |

The database stress testing needs to generate a large number of simulated transactions, which may easily lead to failure or delayed response time of the production database system. Therefore, Yunnan Telecom did not subject the production system to the same stress test as the Intel system. Instead, it used the comparison benchmark on the average response time, and the transactions per second (TPS) value collected from the production system when using HP LoadRunner*, to simulate two virtual users during normal working hours. Based on the results, the Intel database server delivered performance that was far superior to the RISC system.

Telecom Billing System RISC Migration Process

Through the experience gained from the billing system migration project, and combining with Intel's standard RISC migration methodology, the migration project was executed in six phases:

- Phase I: Detailed assessment of RISC solutions and infrastructure
- Phase II: Identify key points in the migration project
- Phase III: Designing migration plan
- Phase IV: Proof of concept
- Phase V: Testing and performance optimization
- Phase VI: Official launch and online operation of the Intel architecture-based system

Table 5 lists the recommended work procedure details during the implementation of each phase.

Table 5. Work Procedure Details

| # | Task | In Charge | Assisting |
|--|--|------------|-----------|
| Phase 1: Detailed assessment of RISC solutions and infrastructure | | | |
| 1.1 | Assessment of the production system hardware and software environment | | |
| 1.1.1 | <ul style="list-style-type: none"> ▪ The physical system architecture including computing system (e.g., processor, memory, drive) storage systems, and network systems | CTC, Intel | ISV |
| 1.1.2 | <ul style="list-style-type: none"> ▪ Logical program structure including overall solution, applications, operating systems, middleware, databases, etc. | CTC, Intel | ISV |
| 1.1.3 | <ul style="list-style-type: none"> ▪ Review and document interdependencies of subsystems | CTC, Intel | ISV |
| 1.2 | System and program performance | | |
| 1.2.1 | <ul style="list-style-type: none"> ▪ Detailed analysis of the overall performance and workload of production systems hardware | CTC, Intel | ISV |
| 1.2.2 | <ul style="list-style-type: none"> ▪ Average and peak transaction processing capacity of the system, system throughput statistics | CTC, Intel | ISV |
| # | Task | In Charge | Assisting |
| | | Intel | |
| Phase 1: Detailed assessment of RISC solutions and infrastructure | | | |
| 2.1 | <ul style="list-style-type: none"> ▪ Identify subsystems/functions that can be improved and find optional/alternative solutions ▪ Ensure systems/functions that can be migrated and confirm there are applicable alternative solutions | | |
| 2.1.1 | <ul style="list-style-type: none"> ▪ Decide which systems/application modules can be migrated and which need to remain as they are | CTC, ISV | Intel |
| 2.1.2 | <ul style="list-style-type: none"> ▪ Analyze the impacts on system connectivity, hardware, and storage devices and changes in interdependencies between subsystems | CTC, ISV | Intel |
| 2.1.3 | <ul style="list-style-type: none"> ▪ Analyze potential ROI/TCO improvement brought about by the RISC migration | CTC, Intel | ISV |
| 2.1.4 | <ul style="list-style-type: none"> ▪ Confirm the migration target and set performance objectives at the system level | CTC, Intel | ISV |
| 2.2 | Define Initial Project Plan and Timetable | CTC, Intel | ISV |
| 2.2.1 | <ul style="list-style-type: none"> ▪ Define phased migration plan and migration pathways | CTC, Intel | ISV |
| 2.2.2 | <ul style="list-style-type: none"> ▪ Identify and assess potential risks in the migration process: ▪ How much time is required by the migration process? ▪ What are the impacts on the production environment? | CTC, Intel | ISV |
| 2.3 | Post-Migration Considerations for IT Maintenance | | |
| 2.3.1 | Identify and assess post-migration consideration: <ul style="list-style-type: none"> ▪ What impact does migration have on post-migration operation and maintenance? ▪ Is there any need to modify existing maintenance processes and procedures? | CTC, ISV | Intel |
| 2.3.2 | <ul style="list-style-type: none"> ▪ Can existing management procedures/tools be reused? | CTC, ISV | Intel |

| Phase III: Designing Server Migration Plan | | | |
|--|--|------------|-----------|
| 3.1 | End-to-End Infrastructure and Solutions | | |
| 3.1.1 | <ul style="list-style-type: none"> ▪ System hardware architecture adjustment solution: ▪ Server hardware configuration, CPU, memory, local storage, network and HBA adapters, etc. ▪ Storage connections and storage space allocation | CTC, Intel | ISV |
| # | Task | In Charge | Assisting |
| 3.1.2 | <ul style="list-style-type: none"> ▪ Logical structure adjustment solution: ▪ Choice of the operating system version, system modules, libraries and documentation requirements ▪ Application system version, database system version requirements ▪ Adjustment solution for interdependencies between the various subsystems | CTC, ISV | Intel |
| 3.1.3 | <ul style="list-style-type: none"> ▪ Analyze ROI/TCO improvements gained | CTC, Intel | ISV |
| 3.2 | Detailed Planning for Database System Migration | | |
| 3.2.1 | <ul style="list-style-type: none"> ▪ Solutions for high availability of database | CTC, Intel | ISV |
| 3.2.2 | <ul style="list-style-type: none"> ▪ Assessment of amount of data, table space planning, indexing and/or partitioning requirements | CTC, Intel | ISV |
| 3.2.3 | <ul style="list-style-type: none"> ▪ Data synchronization solution design | CTC, ISV | Intel |
| 3.3 | Detailed Project Implementation Schedule | | |
| 3.3.1 | <ul style="list-style-type: none"> ▪ Plan for PoCs for key technical aspects | CTC, Intel | ISV |
| 3.3.2 | <ul style="list-style-type: none"> ▪ Overall plan for offline testing of the system | CTC, Intel | ISV |
| 3.3.3 | <ul style="list-style-type: none"> ▪ System move to production procedure and plan | CTC, Intel | ISV |
| Phase IV: Proof of Concept | | | |
| 4.1 | Key Technology Verification Plan | | |
| | <ul style="list-style-type: none"> ▪ Clarify key technical solutions involved during the migration process ▪ Develop appropriate test objectives and test plans | | |
| 4.1.1 | <ul style="list-style-type: none"> ▪ Application system migration | CTC, ISV | Intel |
| 4.1.2 | <ul style="list-style-type: none"> ▪ Database management plan | CTC, Intel | ISV |
| 4.1.3 | <ul style="list-style-type: none"> ▪ Data synchronization tool | CTC, ISV | Intel |
| # | Task | In Charge | Assisting |
| 4.1.4 | <ul style="list-style-type: none"> ▪ Data Migration | CTC, ISV | Intel |
| 4.2 | Proof of Concept Testing | | |
| 4.2.1 | <ul style="list-style-type: none"> ▪ Deploy hardware and software test environment | CTC, Intel | ISV |
| 4.2.2 | <ul style="list-style-type: none"> ▪ Test system optimization | CTC, Intel | ISV |
| 4.2.3 | <ul style="list-style-type: none"> ▪ Migration tools/software testing | CTC, Intel | ISV |
| 4.2.4 | <ul style="list-style-type: none"> ▪ Preliminary performance optimization | CTC, Intel | ISV |

Phase V: Testing

| | | | |
|--|---|------------------|------------------|
| 5.1 | Offline Testing Deploy Intel architecture-based solution Use static production data to conduct a preliminary test on the functionality and performance of the migration solution | | |
| 5.1.1 | ▪ Complete the infrastructure migration according to the step-by-step plan | CTC, Intel | ISV |
| 5.1.2 | ▪ Deploy operating systems, application systems and database systems on the Intel architecture platform | CTC, Intel | ISV |
| 5.1.3 | ▪ Test scenario designs, prepare stress testing script | CTC, ISV | Intel |
| 5.1.4 | ▪ Functional testing, verify if major functional points are running normally | CTC, ISV | Intel |
| 5.1.5 | ▪ Perform offline stress test, compare the stress test results and production environment data, verify whether the test results achieve the set objectives, and make necessary performance optimization based on test results | CTC, Intel | ISV |
| 5.2 | Online Testing Deploy data synchronization tools on the production system based on the offline test resultsDynamically synchronize production data to the Intel architecture system | | |
| 5.2.1 | ▪ Verification of data synchronization tools' functions and performance | CTC, ISV | Intel |
| # | Task | In Charge | Assisting |
| 5.2.2 | ▪ Online stress testing to further confirm functionality and performance of the system, and make necessary optimization based on test results | CTC, Intel | ISV |
| 5.3 | Online Testing Use schedule maintenance window to temporarily cut off the Intel architecture system to the production environment Further confirm the functionality and overall performance of the test system | | |
| 5.3.1 | ▪ Functional testing, verify that all major functional points are functioning properly, verify whether the interdependencies between the Intel architecture system and other subsystems are normal | CTC, ISV | Intel |
| 5.3.2 | ▪ Online performance testing and make necessary optimization based on test results | CTC, Intel | ISV |
| Phase VI: Official launch and online operation of Intel architecture-based system | | | |
| 6.1 | Move to production | | |
| 6.1.1 | ▪ Discuss and develop a detailed go-to-production plan | Intel | CTC, ISV |
| | ▪ Execute system go-to-production procedure according to the plan | CTC | CTC, ISV |
| 6.1.2 | ▪ Official launch and online operation of system | CTC | ISV, Intel |
| | ▪ System is closely monitored before the end of the first billing cycle | | |
| 6.2 | System entering normal operations | | |
| 6.2.1 | ▪ Monitoring and management tools to be deployed in the Intel architecture-based system | CTC, ISV | Intel |
| 6.2.2 | ▪ Prepare and submit manual for maintenance and management of the new system | Intel, ISV | CTC |
| 6.2.3 | ▪ System administrators will recall system and database administration privilege | CTC | Intel, ISV |
| 6.2.4 | ▪ Provide hardware maintenance support interface and technical support standard processes | Intel | |

Test Summary

For the tests described in this paper, the Intel platform-based servers took over about 30 percent of the RISC-based production database's workload. Analyzing performance data through a full billing cycle showed that by offloading just that portion of the workload, the server's CPU and memory usage remained low, with system effectiveness increasing by about three to five times and total cost of ownership (TCO) dropping by nearly 60 percent over the RISC-based system.

The Yunnan Telecom billing system RISC migration project is a comprehensive verification test of the Intel architecture-based system in the telecommunications company billing environment, and the results showed that the Intel architecture system rivaled or surpassed the RISC platform in terms of performance, stability, and system-level solution readiness. The Intel architecture-based system was even far superior to the RISC platform in terms of cost-effectiveness and maintenance costs, among other noted advantages.

With the growth of telecommunications company services in the future, carriers will often encounter performance bottlenecks in RISC platforms in the B/OSS system. They will also have upgrading and expansion costs that exceed their operations and maintenance budgets. Using Intel architecture-based server platforms shows great promise in solving this problem.

Find more information on mission-critical systems powered by Intel Xeon processors at www.intel.com/content/www/us/en/mission-critical/mission-critical-meeting-todays-it-challenges.html

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