HP Server rp7410 Sweet Spot Verification
Business Intelligence Solution
White Paper

Integrated Solutions Deployment Lab
HP Operating Environment Operation

February 25, 2002

1 Product Briefing

1.1 Introduction

Today's businesses demand dependability, adaptability, and efficiency from their information technology solutions—and the HP Server rp7410 fills the bill perfectly. The rp7410 combines rock-solid dependability with comprehensive management and extremely low operational costs. This reliable, high-performance midrange server has the ability to get the job done on time and on budget, while delivering increased efficiencies and a better return on investment. The rp7410 actually minimizes business risk by ensuring that IT resources can meet fast-changing requirements, which leads to greater business profitability today and tomorrow. In short, the rp7410 is the most dependable, adaptable, and efficient midrange server that you can put in the data center.

1.1.1 The Midrange Server Your Business Can Depend On

The HP Server rp7410 provides consistent operation and an extremely robust computing environment. With up to eight PA-RISC processors and up to two hardware partitions, the rp7410 can handle demanding workloads. The rp7410 also offers the most comprehensive high availability feature set in the market, including preventative design, proactive automatic monitoring and fault correction, and redundant components that guard against system failure. In fact, the rp7410 is the *only 8-way server to be certified by the Uptime Institute for fault-tolerant power compliance*!

The rp7410's superior hardware is complemented by its industry leading HP-UX® 11i operating system—the industry's only OS that is compatible with Intel's Itanium processor family (IPF). With a choice of four pre-integrated and tested operating environments, HP-UX 11i allows for quick and effortless deployment. Running HP-UX 11i on the rp7410 also provides integrated security features and up to eight virtual partitions. With HP-UX 11i, the rp7410 runs more than 1,000 Unix programs from leading partners. And of course, the rp7410 and HP-UX 11i are from HP, the preferred choice for market-leading midrange computing solutions.

1.1.2 The Midrange Server That Adapts to Your Business Processes

The adaptable rp7410 lets your data center or IT department evolve intelligently. With best-in-class provisioning capabilities—including flexible partitions in which to assign and distribute CPU cycles, memory, and I/O—the rp7410 allows businesses to adjust computing resources to workload requirements. The rp7410 is also ready to deliver long-lasting value, with easy in-box upgrade paths to future PA-RISC and Itanium processor family technologies, future scaling to 16 CPUs, and a program to migrate existing rp7400 (N-class) customers to the rp7410. And don't forget the added benefits of HP services and support, which help your business quickly adjust to the fast-changing needs of today's marketplace.

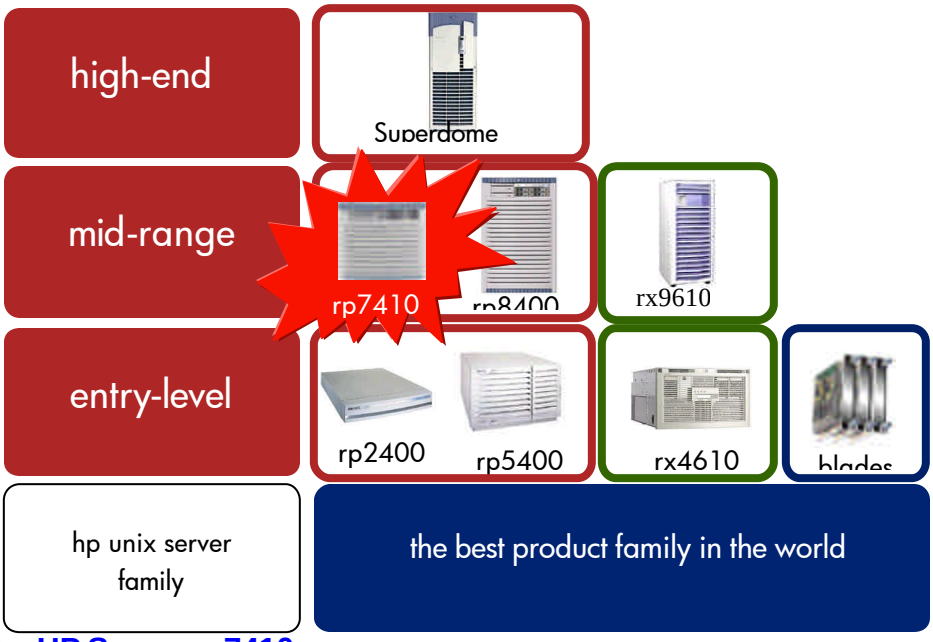
1.1.3 The Midrange Server That Handles Business Workloads Efficiently

The efficient rp7410 can be optimized dynamically and managed seamlessly. Its form factor allows four servers to fit in a standard two-meter rack, packing the maximum performance into every square meter of valuable data center space. Innovative utility computing solutions, such as pay-per-use and capacity-on-demand, reduce up-front investment and allow better alignment of costs to revenues.

Pre-integrated administration tools such as cluster management—together with added authentication and encryption features—provide easier management, more security, and higher quality of service. Integrated software solutions such as HP OpenView™ deliver management across multiple platforms and systems for more control and increased efficiency. As a result, *the rp7410 has the industry's lowest operational costs*!

1.2 HP Unix Server Family

The rp7410 is a midrange server, positioned below the 16-way rp8400. With the addition of the rp7410, HP offers its customers the most complete midrange product line in the industry. The rp7410 continues to build upon HP's leadership in the midrange by providing the computing solutions that businesses demand.



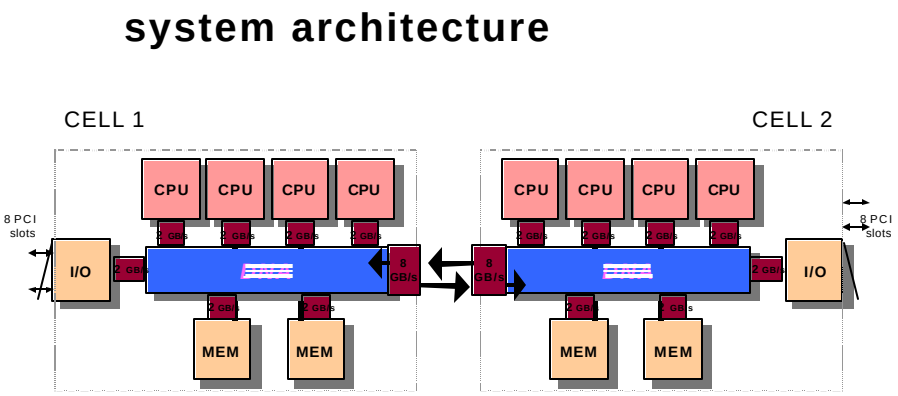
1.3 The HP Server rp7410

According to IDC revenue market share data, HP has held the #1 position in the midrange Unix server market since 1997. Customers have recognized HP's expertise in providing a stable and high-performance platform on which to run their businesses. As the needs of businesses evolve in new directions, HP is committed to providing its customers with solutions that address their challenges. For instance, businesses are experiencing more difficulty than ever in forecasting the computing resources they will require as they grow. Data centers are becoming harder to manage, and consolidation efforts are becoming increasingly critical as operating costs increase dramatically. The cost of these changes and the pace at which significant investments are becoming outdated are challenges that keep IT professionals up at night.

The rp7410 was designed specifically to address these new midrange challenges. Leveraging technology used in HP's high-end Superdome ™ server and the midrange rp8400, the rp7410 provides the dependability, adaptability and efficiency that today's businesses require in the midrange. Some of the distinctive features of the rp7410 include:

Dependability

- 8-way scalability with 650 MHz or 750 MHz PA-8700 CPUs
  The rp7410 provides premier performance with industry-leading PA-8700 processors and high-end cell-based technology. This allows businesses to handle the most demanding workloads with ease. One to two cell boards are able to handle two to four CPUs and 2-32 GB of memory each.



- #1 midrange performance versus comparable servers
  The rp7410 offers leading performance across a variety of business workloads. The rp7410 has a SPEC_jbb2000 performance of 84,600 Java transactions, which is #1 in the 8-way space, and 17%-32% more than the competition. In terms of SPEC_int_rate performance, the rp7410 offers benchmarks that are 28%-45% better than the competition. In terms of price/performance, the rp7410 is far superior to comparable offerings from the competition, with significantly better functionality.

- Robust HP-UX 11i operating environment
  The rp7410 runs the industry-leading HP-UX 11i operating environment. HP-UX addresses the major computing challenges that customers face today in online transaction processing (OLTP), enterprise resource planning (ERP), and customer relationship management (CRM), and is ideal for use in business intelligence systems and in Internet, scientific and technical applications. This mainframe-class, 64-bit operating system enjoys the industry's greatest support from independent software vendors, allowing you to choose from more than 11,000 applications, including native 64-bit versions of all major databases and leading ERP applications.

Adaptability

- Best-in-class partitioning continuum

  HP's industry-leading partitioning continuum offers both flexibility and isolation for fast-moving Internet-based computing. The HP rp7410 delivers dynamic partitioning functionality that includes two hardware partitions, eight virtual partitions, HP's Workload Manager (HP-UX WLM), integration with business applications and the Oracle database, as well as integrated partitions with MC/ServiceGuard™. It's the only Unix solution on the market that features goal-based metrics and automatic instant capacity on demand (iCOD) resource activation integrated with HP-UX WLM, with the capability to isolate operating environments for fast requirement changes.

  The HP rp7410 partitioning continuum delivers flexibility and isolation at the same time.

  - Hardware partitions allow multiple operating system images on the same system with complete hardware and software fault isolation, so that hardware failures to CPUs, memory, or I/O only impact the affected partition without affecting other partitions.

  - Virtual partitions allow multiple operating system images to run on the same system with complete software fault isolation, so that application or OS failures only impact the affected virtual partition without interrupting other partitions.

  - Resource partitions are unique partitions created for workload management to meet the resource needs of the many different applications running on one server. HP's Workload Manager and Process Resource Manager (PRM) software allocate CPU, memory, disk, and I/O resources among multiple applications and/or users.

- Industry-leading investment protection through in-box upgrades and upgrades to rp8400
  The rp7410 is in-box upgradeable to future generations of PA-RISC processors as well as IPF processors. This gives companies the opportunity to decide which architecture better suits their needs over time, and to make transitions without being forced to make substantial unplanned investments. Instead, businesses can safely invest in the rp7410, knowing that it will keep them on the leading edge of technology. HP's in-box upgrade approach differs radically from that of other vendors, which often require expensive box-swaps in order to fully realize improvements in technology.

  The rp7410 shares components with the rp8400, including CPUs, cell boards, memory, PCI cards, and internal disk and peripherals. This enables components to be swapped between servers and allows customers to upgrade to the rp8400 chassis if additional scalability is required, while maintaining the ability to reuse the rp7410 components in the upgrade process.

Efficiency

- Best-in-class performance density
  The rp7410 has a 10u form factor, allowing two servers to fit within a standard two-meter rack. This gives customers the performance of four rp7410s in a single rack. To achieve a comparable level of performance, customers would need two racks of IBM midrange servers or four racks of Sun servers. In addition to saving floor space and associated costs, savings also come from lower support costs. Overall, the performance density of the rp7410 allows businesses to gain significant operational cost savings when compared to competitive products.

- Innovative utility pricing program
  HP delivers the most comprehensive utility pricing program in the industry. The rp7410 offers customers three choices to better utilize their computing resources and to better align cost outlays to revenue streams—pay-per-use, pay-per-forecast, and instant capacity on demand.

- Pay-per-use: In order to meet today's customer concerns about capital outlay, HP offers pay-per-use plans that help reduce customers' total cost of ownership (TCO) and help them align usage with their business model. This unique program charges customers on a per-usage basis, so they pay only for the computing power they use. Pay-per-use reduces costs and increases cost predictability by aligning usage with revenue. Pay-per-use is best for customers who have less predictable growth, and those with volatile workloads that may need temporary capacity increases.

- Pay-per-forecast: Similar to pay-per-use, pay-per-forecast is designed to better align a customer's costs with usage. Pay-per-forecast is appropriate for businesses that have stable and predictable fluctuations in demand, which can be forecast accurately ahead of time.

- Instant capacity on demand: This program delivers instant capacity dynamically to servers and storage. Configured as a lease, it is priced as a combination of fixed and variable costs. iCOD allows planning for unpredictable demand and aligns expenditures with usage via a singe command. It offers extra processing power for future growth and ensures availability. Its competitive price is particularly appealing to budget-conscious customers who want to achieve high availability during periods of peak demand. iCOD is the right choice for customers who need more predictable growth, but have a less volatile workload and want permanent capacity increases.

HP Server rp7410 Features At A Glance

Standard Features and Capacities

- 1-2 CPU/memory cell boards, hot-plug
- 2-8 PA-8700 64-bit CPUs @ 650 MHz or 750 MHz. (Upgradeable to 16 CPUs with future processor generations)
- Up to 32 GB of memory (To 64 GB with future upgrades)
- 15 PCI card slots (66-MHz x 64 bit) with pushbutton (doorbell) hot-plug functionality[1]
- 2 hot-plug redundant core I/O cards[2]
- Built-in management processor
- Integrated Web Console
- Up to 4 internal hot-plug disk drives (18, 36 and 73 GB)
- 1 hot-plug removable-media bay (DVD or DAT)
- Easy upgrades to future PA and IPF processors

Speeds and Feeds

- 530-MB/s PCI link bandwidth per slot (14 of 15 slots)
- 8.5-GB/s I/O slot bandwidth (peak)
- 8-GB/s bandwidth (peak) for cell-controller-to-memory subsystem
- 8-GB/s Cell to Cell link (peak)

Partitioning

- 1-2 nPartitions in hardware
- Up to 8 virtual partitions (vpars)[3]

High Availability

- 2N Redundant hot-swap power supplies
- Redundant hot-swap fans, all with HP SmartFan technology
- Redundant power line inputs for dual grid coverage
- ECC on all CPU and memory paths
- ECC on all system cache memory
- Main memory DRAM kill resiliency (“chip kill”)
- Redundant dc/dc converters for key subsystems
- Parity-protected I/O data paths
- Independent I/O paths

Operating System

- HP-UX 11i operating environment (IPR 0203 or later)
- Future Linux and Windows support with IPF

Physical Characteristics

- Rack-mount and pedestal[4] configurations
- Height:
  - Racked chassis: 10 EIA units (44.45 cm, or 17.5 in)
- Depth: 76.20 cm, or 30 in
- Width: 48.26 cm, or 19 in

[1] Doorbell feature enabled with future release of HP-UX operating system.
[2] Redundant core I/O enabled with future release of HP-UX operating system.
[3] Virtual partitions supported 2H-2002.
[4] Pedestal version available 2H-2002.

2 Overview

2.1 Purpose of the White Paper

The purpose of this white paper is to reduce our customers' deployment time and to improve the total customer experience for their rp7410 system(s). Customer-focused testing reduces deployment issues by validating and documenting all major software elements necessary for a use-case scenario in a given configuration.

The configuration information in this document will enable customers and HP field personnel to recreate the environments that successfully passed our tests. Please note that while these configurations are known to work, they have not been fine tuned and may need further refinement for particular workloads.

2.2 Test Scope

2.2.1 Purpose of the Test

The main purposes of the rp7410 test are to:

- Validate that rp7410s can be configured and will work in anticipated customer usage patterns.
- Provide sales literature to demonstrate that HP has implemented complex, real world environments.
- Provide support information that indicates one way that complex configurations can be implemented.

Potential usage patterns for testing were evaluated based upon the rp7410's capabilities and its position in the HP server family. The rp7410 is an "upper" midrange server, with up to eight CPUs, 32 gigabytes of RAM, and 16 PCI slots. It uses the same "cell" technology as the rp8400, allowing it to have up to two "hard" partitions or "nPars". In the HP server family, it is equivalent to the N-Class and rp7400 servers, but with cell technology and a smaller footprint.

The Business Intelligence simulations were implemented with a single partition rp7410 as the database and application server (single-tier implementation).

2.2.2 Focus of the Test

Certifying that the rp7410 customer solutions actually work as anticipated—and validating that the customer solutions can actually be set up—are the focus of this test. This testing was done on an rp7410 prototype with a companion system to simulate a computer center.
This test:

- Is completely solutions-focused.
- Performs interoperability testing to verify that all hardware and software components work together.
- Leverages resources across multiple HP organizations.
- Supports information available on the web indicating one way that complex configurations can be implemented.
- Includes a combination of multiple testing methodologies and market/customer data.
- Performs anticipated customer configuration usage/load simulation tests.

- Provides initial solution configurations for highest priority customers.
- Provides functionality and compatibility verification of third-party products.

This test is not:

- Achievable by any one HP organization.
- Just one type of test.
- Driven by internal specifications, technology or organizational charts.
- A minimum or maximum configuration test.
- HP-UX, server, or ISV testing.

2.2.3 Methodology of the Test

The test methodologies that were utilized during the customer simulations include:

- Configuration testing— covering the top rp7410 customer solutions.
- Installation testing— validating the correct installation of operating environment and layered software.
- Load testing— characterizing system response to specific simulated database loads.
- Compatibility testing— validating compatibility with HP-UX 11.0 and HP-UX 11i ISVs.
- Documentation testing— validating customer documentation during the system set-up, configuration, and re-configuration processes.
-

2.3 Feedback to the Document

For questions and comments, please send mailto:meiyee_proj@cup.hp.com.

3 Business Intelligence Solution Stack

3.1 Introduction

The scope of the Business Intelligence simulation is to model: (1) An SAS data warehouse application single-tier installation, and (2) an Oracle 8i single-tier data warehouse (~1.5 terabytes) running typical queries and updates over 48 hours. In both cases, our tests simulate the customer environment in terms of the software stack, but not necessarily in terms of the division of applications, database, and users across the network.

3.2 Major Hardware Components

- HP Server rp7410 with 8 CPUs and 16 gigabytes of RAM.
- Eight HP SureStore ™ E Disk System FC10's with 10 36-gigabyte disk drives each.

3.3 Major Software Components

- HP-UX 11i Enterprise Operating Environment (March 2002 OEUR)
- HP Fortran, C and C++ compilers
- Oracle 8.1.7, 64-bit
- SAS ® Software, Release 8.2, 64 bit
- Platform Verification Test Suite (PVTS) – internal product validation suite from SAS

3.4 Software Solution Stack

Verification	**Software Installed**
SAS Applications Suite	SAS (version 8.2/64 bit), PVTS 3.1(HP-UX/64 bit), PVTS3.1 (Oracle/64 bit)
Oracle Data Warehouse	Oracle RDBMS, version 8.1.7 (64 bit)

Table 3.1

4 HP Server rp7410 as SAS Application (and Oracle Database) Server

4.1 Overview

This test is to verify the SAS System running on HP-UX 11i on the rp7410 using the SAS Institute's PVTS (Platform Verification Test Suite).

PVTS is a self-contained, platform specific test-ware system consisting of tests and tools used by the SAS Institute Development Testing Groups. The purpose of the PVTS System is that of an assessment tool, not as a debugging or performance verification tool. The system consists of over 3,000 tests, input files, benchmark files, and the necessary tools to run the system and generate reports. The overall pass percentage represents a partial measure of the degree to which the platform being tested is compatible with SAS.

PVTS contains tests that exercise the major components of the SAS software, as well as extensions (such as SAS/ACCESS to Oracle) to validate proper interactions between the SAS software, Oracle software, the HP-UX operating system software, and underlying hardware.

4.2 Network Topology

Since PVTS was implemented in a single-tier configuration, networking and network traffic was limited to the system under test and the various test engineers workstations (for test invocation and monitoring purposes). The rp7410 was connected to the HP intranet via the 10/100/1000 Base-T connector on the Core IO card (hardware address 0/0/8/0/0/4/0). Although the software stack communicated internally via sockets, network traffic into and out of the system was light.

4.3 System Topology

As mentioned in *Network Topology* above, the tests were implemented in a single-tier configuration. All software—database, applications, and simulated users—were run on a single 8-CPU partition on the rp7410. An actual deployment would probably use two to four tiers, based on the actual needs of the application environment.

4.4 Hardware Configuration

Model: 9000/800/rp7410
Main Memory: 16 GB
Processors: 8 (on 2 cell boards)
OS mode: 64-bit
Storage Devices:
Internal -
(2) HP 18.2GST318404LC
External –
(40) HP 36.4GST336605FC
I/O Interfaces: (2) MP/SCSI board –

- Ultra160 Wide LVD (internal mass storage) SCSI (A6793-60001)
- Ultra Wide Single Ended (internal removable storage) SCSI (A6793-60001)
- RS-232 (UPS control / general purpose)
- RS-232 (external modem)
- RS232 (local console)

- 10/100 Base-T (LAN console)

(2) LAN/SCSI board –

- Ultra160 Wide LVD (internal mass storage) SCSI (A6793-60001)
- Ultra160 Wide LVD (external channel) SCSI (A6793-60001)
- 2nd Generation 10/100/1000 Base-TX LAN using an RJ45 connector

(8) HP Tachyon TL/TS Fibre Channel Mass Storage Adapter

For a tabular layout of the rp7410's hardware components, see Appendix A – System Hardware List.

4.5 Software Product List

Products	Version	Description
Products contained in bundle(s)		
B5013AA	C.03.10.00	HP PerfView Analyzer for s800 11i
B5015AA	C.03.10.00	HP PerfView Monitor for s800 11i
B5017AA	C.03.10.00	HP PerfView Planner for s800 11i
Base-VXVM	B.03.20.1	Base VERITAS Volume Manager 3.2 for HP-UX
CDE-English	B.11.11	English CDE Environment
FDDI-00	B.11.11.02	PCI FDDI;Supptd HW=A3739A/A3739B;SW=J3626AA
FDDI-02	B.11.11.01	HPPB FDDI;Supptd HW=J2157B;SW=J2658BA
FibrChanl-00	B.11.11.09	PCI/HSC FibreChannel;Supptd HW=A6684A, A6685A, A5158A, A6795A
GigEther-00	B.11.11.14	PCI/HSC GigEther;Supptd HW=A4926A/A4929A/A4924A/A4925A;SW=J1642AA
GigEther-01	B.11.11.02	PCI/PCI-X GigEther;Supptd HW=A6794A
HPUX11i-OE-Ent	B.11.11.0203	HP-UX Enterprise Operating Environment Component
HPUXBase64	B.11.11	HP-UX 64-bit Base OS
HPUXBaseAux	B.11.11.0203	HP-UX Base OS Auxiliary
OnlineDiag	B.11.11.06.04	HPUX 11.11 Support Tools Bundle, March 2002
RAID-00	B.11.11.01	PCI RAID; Supptd HW=A5856A
perl	B.5.6.1.C	Perl Programming Language
Products not contained in bundle(s)		
IGELAN-DRV	B.11.11.02	HP PCI Gigabit Ethernet Driver

Table 4.1

4.6 Patches

Products	Version	Description
Patches contained in bundle(s)		
BUNDLE11i	B.11.11.0102.2	Required Patch Bundle for HP-UX 11i, February 2001
GOLDAPPS11i	B.11.11.0112.6	Gold Applications Patches for HP-UX 11i, December 2001
GOLDBASE11i	B.11.11.0112.6	Gold Base Patches for HP-UX 11i, December 2001
HWEnable11i	B.11.11.0203.3	Hardware Enablement Patches for HP-UX 11i, March 2002 *(pre-release version)*
Patches not contained in bundle(s)		
PHCO_24118	1.0	Cumulative SAM patch
PHKL_25712	1.0	SCSI Ultra160 Driver with OLAR support
PHNE_25642	1.0	Cumulative ARPA Transport patch
PHNE_25084	1.0	Cumulative STREAMS Patch
PHNE_24492	1.0	LAN product cumulative patch

Table 4.2

4.7 System Configuration

4.7.1 Kernel Parameter Changes

STRMSGSZ	65535
dbc_max_pct	25
default_disk_ir	1
desfree	1024
Lotsfree	8192
max_thread_proc	500
maxdsiz	0x7B03A000
maxdsiz_64bit	4396972769279
maxfiles	200
maxfiles_lim	2048
maxssiz	401604608
maxssiz_64bit	1073741824
maxswapchunks	8096
maxtsiz	1073741824
maxtsiz_64bit	0x7B03A000
maxuprc	4096
maxusers	1024
maxvgs	128
minfree	256
msgmax	32768
msgmnb	32768
msgseg	7168
msgtql	256
nfile	30000
nflocks	8000
ninode	15000
nproc	20480
npty	512
nstrpty	60
scroll_lines	512
semmni	2048
semmns	2048
semmnu	2048
shmmax	1073741824
shmmni	512
shmseg	64
swchunk	10240
timeslice	1
timezone	480
unlockable_mem	77828

Table 4.3

4.7.2 Resolver Configuration File Setup (/etc/resolv.conf)

```
#/etc/resolv.conf
domain          rose.hp.com
nameserver      15.29.40.2
```

4.7.3 Name-service Switch Setup (/etc/nsswitch.conf)

```
#/etc/nsswitch.conf
passwd:         files
group:          files
hosts:          files [NOTFOUND=continue TRYAGAIN=continue] dns
networks:       files
protocols:      files
rpc:            files
publickey:      files
netgroup:       files
automount:      files
aliases:        files
services:       files
```

4.8 Oracle Application Installation

These tests were run on an Oracle database (version 8.1.7, 64-bit) that was installed with “standard/typical” options. The one non-standard step was to answer “Yes” to the prompt asking whether to re-link the shared library extensions. This is necessary to generate the Oracle Client Shared Libraries, which are required by SAS.

4.9 SAS Application Installation

For test purposes, it is recommended that all software provided on the SAS system media be installed. The processes used were the steps for a "Default Installation" for HP-UX in the *INSTALLATION INSTRUCTIONS FOR THE SAS SYSTEM UNDER UNIX ENVIRONMENT*S. The "Default Installation" installs everything on the installation media to the destination directory. The installation required 1 gigabyte of disk space.

The steps to install the SAS system were:

Step 1: Inserted the SAS installation disk into the CD-ROM drive, and mount the CD:

```
mkdir /cdrom
mount –r /dev/cd0 /cdrom
```

Step 2: Prepared the destination directory.

If the directory does not already exist, the installation procedure will create it. The important thing was to make sure that the destination directory had adequate disk space available.

Step 3: Launched the SAS setup executable:

```
/cdrom/sassetup
```

Step 4: Followed the instructions in the setup, and installed the SAS system.

4.10 Platform Validation Test Suite (PVTS) Installation

After successful installation of the SAS software, the next step was to install and configure PVTS. PVTS was successfully installed and configured per the guidelines provided by SAS. PVTS provides scripts to set user environment variables and establish the test environment. The configuration and successful installation is verified as a part of the PVTS test run.

4.11 SAS Application Configuration

The application software was configured as per the guidelines provided by SAS for platform verification.

4.12 Test Procedure

The command "*run.pvts*" was executed as a non-root user.

4.13 Test Result

The following portrays the actual results generated by running the PVTS, PVTS/Oracle on a SAS system on the rp7410:

HP-UX	PA	PVTS_H64	ORACLE	Bequeath	SQL*Net/Net8
11i/64	2.0	passed			
	2.0		8.1.7/64	passed	passed

4.14 Known Problems and Tips

There were no problems observed. The test passed without any SAS or Oracle patches, and with only those HP-UX patches referred to in Section 4.6 ("Patches") above.

Configuration guidelines for installing and configuring SAS on HP-UX may be found in the HP/SAS Configuration Guide at http://www.sas.com/partners/directory/hp/hpuxwp.pdf. Additional information on the HP/SAS relationship may be found at http://www.sas.com/partners/directory/hp/index.html.

5 HP Server rp7410 as Oracle Database (Data Warehouse) Server

5.1 Overview

The scope of this test is a "market basket analysis" simulation. It is based upon the business requirements and data models used by a number of our large supermarket chain customers. The test package employs two fact tables and five dimension tables, and exercises a variety of time-consuming queries from simulated users (5–125). All of the data is managed by an Oracle 8.1.7 64-bit RDBMS, which functions as the data warehouse server.

5.2 Network Topology

Since the Oracle data warehouse test was implemented in a single-tier configuration, networking and network traffic was limited to the system under test and the various test engineers workstations (for test invocation and monitoring purposes). The rp8400 was connected to the HP intranet via the 10/100/1000 Base-T connector on the Core IO card (hardware address 0/0/8/0/0/4/0). Although the software stack communicated internally via sockets, network traffic into and out of the system was light.

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Base-VXVM	B.03.20.1	Base VERITAS Volume Manager 3.2 for HP-UX
CDE-English	B.11.11	English CDE Environment
FDDI-00	B.11.11.02	PCI FDDI;Supptd HW=A3739A/A3739B;SW=J3626AA
FDDI-02	B.11.11.01	HPPB FDDI;Supptd HW=J2157B;SW=J2658BA
FibrChanl-00	B.11.11.09	PCI/HSC FibreChannel;Supptd HW=A6684A, A6685A, A5158A, A6795A
GigEther-00	B.11.11.14	PCI/HSC GigEther;Supptd HW=A4926A/A4929A/A4924A/A4925A;SW=J1642AA
GigEther-01	B.11.11.02	PCI/PCI-X GigEther;Supptd HW=A6794A
HPUX11i-OE-Ent	B.11.11.0203	HP-UX Enterprise Operating Environment Component
HPUXBase64	B.11.11	HP-UX 64-bit Base OS
HPUXBaseAux	B.11.11.0203	HP-UX Base OS Auxiliary
OnlineDiag	B.11.11.06.04	HP-UX 11.11 Support Tools Bundle, March 2002
RAID-00	B.11.11.01	PCI RAID; Supptd HW=A5856A
perl	B.5.6.1.C	Perl Programming Language
Products not contained in bundle(s)		
IGELAN-DRV	B.11.11.02	HP PCI Gigabit Ethernet Driver

Table 5.1

5.6 Patches

Products	Version	Description
Patches contained in bundle(s)		
BUNDLE11i	B.11.11.0102.2	Required Patch Bundle for HP-UX 11i, February 2001
GOLDAPPS11i	B.11.11.0112.6	Gold Applications Patches for HP-UX 11i, December 2001
GOLDBASE11i	B.11.11.0112.6	Gold Base Patches for HP-UX 11i, December 2001
HWEnable11i	B.11.11.0203.3	Hardware Enablement Patches for HP-UX 11i, March 2002
Patches not contained in bundle(s)		
PHCO_24118	1.0	cumulative SAM patch
PHKL_25712	1.0	SCSI Ultra160 Driver with OLAR support
PHNE_25642	1.0	cumulative ARPA Transport patch
PHNE_25084	1.0	Cumulative STREAMS Patch
PHNE_24492	1.0	LAN product cumulative patch

Table 5.2

5.7 System Configuration

5.7.1 Kernel Parameter Changes

STRMSGSZ	65535
dbc_max_pct	25
default_disk_ir	1
desfree	1024
lotsfree	8192
max_thread_proc	500
maxdsiz	0x7B03A000
maxdsiz_64bit	4.39697E+12
maxfiles	200
maxfiles_lim	2048
maxssiz	401604608
maxssiz_64bit	1073741824
maxswapchunks	8096
maxtsiz	1073741824
maxtsiz_64bit	0x7B03A000
maxuprc	4096
maxusers	1024
maxvgs	128
minfree	256
msgmax	32768
msgmnb	32768
msgseg	7168
msgtql	256
nfile	30000
nflocks	8000
ninode	15000
nproc	20480
Npty	512
Nstrpty	60
Scroll_lines	512
Semmni	2048
Semmns	2048
Semmnu	2048
Shmmax	1073741824
Shmmni	512
Shmseg	64
Swchunk	10240
Timeslice	1
Timezone	480
Unlockable_mem	77828

Table 5.3

5.8 Oracle Installation

Step 1. The logical volume "oracle" was created in volume group "vgbi" with a size of 5000 megabytes and mounted to "/mnt".

Step 2. The directory "/mnt/817_64" was created, and a symbolic link ("/oracle") was placed in "/". This is standard procedure for validating compatibility with Oracle databases, since it allows the installation of multiple versions of the database under /mnt. (For normal usage, the creation of a "/oracle" directory with 3 gigabytes of space would be sufficient.)

Step 3. The user "oracle" (UID: 4000) and group "dba" (GID: 4000) were added to the files "/etc/passwd" and "/etc/group", respectively.

Step 4. The 64-bit version of the Oracle RDBMS revision 8.1.7 was installed using the "typical" installation option.

5.9 "Market Basket Analysis" Simulation Installation

A 150-megabyte tar file containing the simulation was placed on the system. The simulation package contains:

- Data: There are seven files of data that which are loaded into two fact tables – daily_sales and daily_forcast and five dimension tables – store, promotion, product, period and customer.
- Init_files: There are two init.ora files with different "sort_area_size" settings.
- *Init.tmp* is used to set up the database. The "sort_area_size" is set to a big number for bitmap index creation purposes.
- *Run_init.pops* is used at test time. The value of "sort_area_size" is relatively small compared to the value in the "init_tmp" file.
- Scripts: All of the setup scripts necessary for creating and linking the logical volumes and setting up the database are included.
- Test: There are three types of executables:
  Queries: All the SQL scripts including many star queries that are used to access the database.
  Scripts: All the test scripts that are used to invoke the workload testing.
  Suites: All the test suites that are used to simulate the workload with different scaling in terms of users.

The simulation package was installed under "/mnt".

5.10 Simulation Customizations

- init_files/init.tmp: This acts as "init.ora" for the database setup. Make sure the following parameters are modified to comply with the specific database version.
- Compatible: Always fill in the current version of the Oracle RDBMS such as 8.1.7
- Control_files: Always fill in the actual path.
- Processes: Modify 200 to 300 if the database version is greater than 8.1.5. The processes forking might fail if the value is less than 300 in the version of 8.1.7 at database setup time.
- Sort_area_retained_size: Make the value equal to "sort_area_size" if the database version is greater than 8.1.5 (This is a known Oracle bug, if the value of sort_area_retained_size is less than sort_area_size, ORA-600 internal error is encountered when creating bitmap index)
- scripts/lvm_db.sh: This script is used to setup raw devices and file systems for creating test database. It always needs the following modifications to reflect the physical device path and disk distributions:
  DEV[1] to DEV[50]: We are using 50 x 36GB disk devices, therefore there would be total 50 DEV array elements containing the actual device path.
  SYS_DSK: Records the disk device path for system file.
  LOG_DSK[1] and LOG_DSK[2]: Records two device path values for two log files.

DAT_DSK: Records 47 disk device path values. The disk devices used for "system" file and "log" files would not be used for the data disk purpose.

- DEF_DSK: Records the disk device path for default tablespace purpose and which is usually the same disk for the system file.
- IDX[1] to IDX[5]: Records 10 disk device path value for each IDX array element.
- Function clean_phys_volumes: Modify the index "i" to reflect the actual number of disk devices used (which is 50 in this case).
- Function create_phys_volumes: Modify the index "i" to reflect the actual number of disk devices used (which is 50 in this case).
- Function create_logical_volumes: Make the following changes:
- Modify the index "i" to reflect the actual number of disk devices used (which is 50 in this case).
- Modify the size of default file from 2MB to 200MB. For the detailed reasons, please refer to the last section " Known problems and Tips".
- Modify the number of disks to stripe across for temporary space files in the command "lvcreate". The original number of stripes is "12". It is OK when disk device size is 18GB or 36GB. For 72GB size, the number of disks to stripe across is reduced to "7". The value is figured out based on the information of "vgdisplay –v" when the failure to "lvextend" the temporary space is encountered.
- Modify the group of the tester "oracle" to reflect the actual group name is used. The original group is "orainstall" and we are using "dba" instead.
- scripts/create.sh: This script is used to create and setup the test database. There are two modifications that need to be made:
  Change the size of default tablespace from 2MB to 199MB.
  Set the temporary space of the user "sys" to "ts_temp".
- test/scripts/multi.tst: Uncomment the commented out tests including "quick', "easy", "medium" and "intense" test suites.

5.11 Test Procedure

5.11.1 "Market Basket Analysis" Simulation

It took approximately 46 hours to complete the test setup. Forty minutes were needed to set up the raw devices, and 45 hours were needed to initialize the test database. Tasks that had to be performed manually included:

- Directories for the executable scripts, queries and suites had to be created.
- Directories for the database and output had to be created.
- Test executables had to have variables initialized to point to the proper working, output and result directories.
- Data files had to be "gunzip'ed".
- Logical volumes for the test database had to be created via a setup script (lvm_db.sh). The volumes were created as:
- System file (816M)
- Log files (4300M x 2)
- Data files (10896M x 52)
- Index files (4080M x 52)
- Temp space files (14304M x 30)
- Default space file (200M)
- The logical volumes were linked to database file names via a second script (lvm_link.sh).
- A final script (create.sh) performed the actual database initialization:
- Create the test database
- Create public rollback segments
- Create tablespaces for default space, temporary space, fact tables, dimension tables and all the indexes. (10 hours 33 minutes)
- Build data dictionary (follow the setup of TPC-D)
- Create the test user and set the default table space and temporary table space for the user.

- Create dimension tables and fact tables (partitioned)
- Disable constraints
- Load data to all the tables. (3 hours 25 minutes)
- Gather global statistics, follow the setup of TPC-D
- Ensure that any bitmap indexes subsequently created will be as small (compressed) as possible (3 hours 40 minutes)
- Create indexes for each table (15 hours 22 minutes)
- Add primary keys for fact tables
- Enable the constraints back. (7 hours 25 minutes)
- Set degree of parallelism for tables and cache the dimension tables

5.11.2 Simulation Execution

The top level test script (multi.tst) invokes the test driver (run_multi.sh) on the test suites with multiple users (scaling from 5 to 125). It takes about twenty-four hours to finish all the workload testing.

The test suites are classified into the following five categories:

- **Easy_xxx**: The test suite contains multiple (such as 75) easy queries and each of which will finish in <= 5 minute. Easy_75 represents that 75 users access the database simultaneously with each user invoking one corresponding SQL script in the test suite
- **Quick_xxx**: The test suit contains multiple (such as 125) quick queries and each of which will finish in very short time say <= 1 minute. Quick_125 represents that 125 users access the database simultaneously with each user invoking one corresponding SQL script in the test suite.
- **Medium_xxx**: The test suite contains multiple (such as 50) medium queries and each of which will finish in <= 20 minutes. Medium_50 represents that 50 users access the database simultaneously with each user invoking one corresponding SQL script in the test suite.
- **Intense_xxx**: The test suite contains multiple (such as 25) intense queries and each of which will finish in <= 1 hour. Intense_25 represents that 25 users access the database simultaneously with each user invoking one corresponding SQL script in the test suite.
- **Mixed test suites**: Each mix test suite is naming as Q*xx*E*xx*M*xx*I*xx*. An example may be "q25e15m10i5". It indicates that the test suite contains 25 quick queries, 15 easy queries, 10 medium queries, 5 intense queries and 55 users access the database simultaneously with each user invoking one corresponding SQL script in the test suite.

5.11.3 CPU Utilization in the Different Simulations

The following two parameters are used in the simulation:

- CPU_count
- Parallel degree

The performance of the workload testing might vary depending on the settings of the above two parameters. The default of "Degree Of Parallel" is "2 * cpu_count". If more DOP is desired, please modify "scripts/alter_dop.sql" accordingly and execute the SQL script before starting the workload testing.

5.11.1.1 CPU 8 and DOP 16

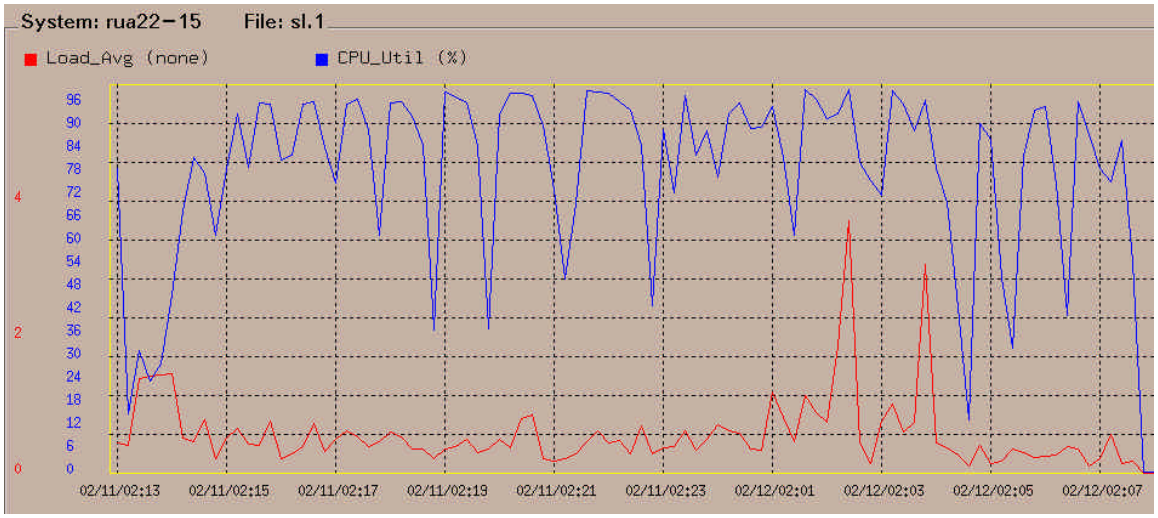

Figure 5.1

Figure 5.1 shows the CPU usage over time when Oracle's "virtual CPU" setting was 8 and the "Degrees of Parallelism" was set to 16. (The lower curve shows load average – the number of processes waiting in the run queue)

5.11.1.2 CPU 8 and DOP 40

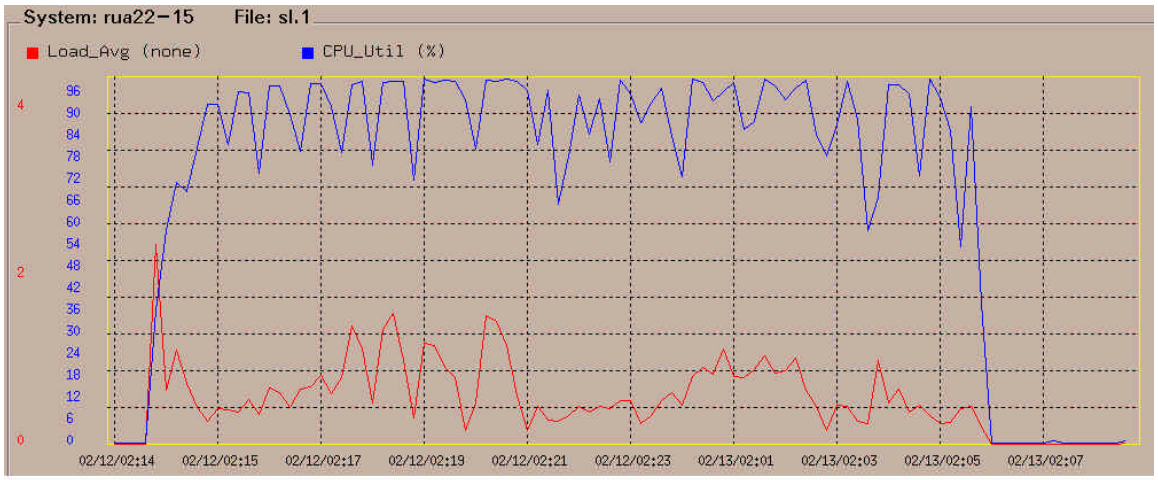

Figure 5.2

Figure 5.2 shows the CPU usage over time when Oracle's "virtual CPU" setting was 8 and the "Degrees of Parallelism" was set to 40.

5.12 Test Result

All the outputs for each test suite can be found in the output result directory "$OUT" which includes all the SQL script output files, error list, done list, system activity reporter file and virtual memory statistics.

The following table illustrates the test response time in the format hh:mm:ss (hours:minutes:seconds).

Test Suite	Active CPU count/ Oracle CPU count/ Parallel Degree 8/8/16	Active CPU count/ Oracle CPU count/ Parallel Degree 8/8/40
Easy_15	00:02:07	00:03:04
Easy_25	00:03:50	00:04:02
Easy_35	00:05:10	00:04:08
Easy_45	00:07:28	00:03:59
Easy_55	00:09:22	00:04:24
Easy_65	00:10:46	00:06:25
Easy_75	00:10:44	00:07:09
Quick_25	00:00:46	00:00:32
Quick_50	00:01:51	00:01:52
Quick_75	00:02:14	00:02:16
Quick_100	00:02:39	00:02:40
Quick_125	00:02:43	00:02:35
Medium_10	00:13:35	00:15:04
Medium_15	00:25:56	00:28:31
Medium_20	00:44:47	00:38:37
Medium_25	00:52:45	00:44:22
Medium_30	00:55:12	00:47:35
Medium_35	01:03:30	00:41:55
Medium_40	01:05:39	00:46:18
Medium_45	01:31:31	01:10:17
Medium_50	01:37:02	01:12:28
Intense_5	00:23:50	00:28:21
Intense_10	00:51:14	00:50:54
Intense_15	01:24:54	00:23:55
Intense_20	01:36:37	01:18:56
Intense_25	01:47:03	01:34:00
q25e15m10i5	00:46:16	00:48:26
q50e25	00:07:16	00:04:42
q50m25	00:56:10	00:48:14
q50e15m10i5	00:48:02	00:49:52
q50e15m10	00:29:46	00:19:55

Table 5.4

5.13 Known Problems and Tips

5.13.1 Known Problems

- *ORA-00600: Internal error.* This occurred when creating bitmap indexes for fact tables. This is a known bug for Oracle 8.1.6 and 8.1.7. A formal fix from Oracle is still not available. To work around, the value of "sort_area_retained_size" has to equal to the value of "sort_area_size" in "init.tmp" file

- *ORA-00020: Maximum number of processes (600) exceeded*. This error may occur when workload testing is invoked. Make sure to increase the parameter of "processes" in "init.tmp" at setup time or in "run_init.pops" at run time. The original script set the value of 200 for version 8.1.5. It is recommended to set the value to 300 at setup time and 400 at runtime for Oracle version 8.1.6 and 8.1.7.
- ORA-12801: Error signaled in parallel query server and ORA-04030: out of process memory when trying to allocate memory.
- The command *swapinfo –tm* may be used to check whether the system has enough s wap space. This simulation required at least six gigabytes of swap.
- The kernel parameters *nproc*, *maxswapchunks* and *swchunk* must be set properly.
- *ORA-27142: Could not create new processes*. The kernel parameter *nproc* may not be big enough.
- ORA-01652: Unable to extend temp segment by XXX bytes in tablespace SYSTEM. Instead of increasing the size of SYSTEM tablespace, perform the DDL command alter user sys temporary tablespace ts_temp.
- The table space utilization of the database setup in version 8.1.7, 64-bit is as follows:

TBSP	MEG	FREE	USED	PCTUS
SYSTEM	815	642	173	22%
TS_DEFAULT	199	198	1	1%
TS_DIM_INDX	47	23	24	52%
TS_DIM_TBL	119	18	101	85%
TS_FACT_IDX_1	4079	1159	2920	72%
TS_FACT_IDX_2	4079	1159	2920	72%
TS_FACT_IDX_?	4079	1159	2920	72%
TS_FACT_IDX_51	4079	1159	2920	72%
TS_FACT_IDX_52	4079	1159	2920	72%
TS_FACT_TBL_1	10895	1539	9356	86%
TS_FACT_TBL_2	10895	1539	9356	86%
TS_FACT_TBL_?	10895	1539	9356	86%
TS_FACT_TBL_51	10895	1539	9356	86%
TS_FACT_TBL_52	10895	1539	9356	86%

Table 5.5

There are a total of 108 table spaces in table 5.5. "*TS_FACT_IDX_?*" represents entries from "*TS_FACT_IDX_3*" to "*TS_FACT_IDX_50*" and "*TS_FACT_TBL_?*" represents entries from "*TS_FACT_TBL_3*" to "*TS_FACT_TBL_50*".

5.13.2 General Tips

- The Oracle *oerr ora <error code>* command may be used to find the probable *Cause* and recommended *Action* for Oracle error messages.
- Some problems may be fixed by retuning kernel parameters.
- The web site http://metalink.oracle.com provides access to the Oracle bug database. Known problems always contain fix information or work-arounds.

6 Appendix A – HP server rp7410 Test System Layout

Hostname	Model	# of Processors	CPU Speed
rua22-15 Partition 0 rua22-14 Mgmt Proc	9000/800/rp7410	8 CPU	750 MHz

Backplane Layout

Bay 0 Chassis 0	Bay 0 Chassis 1
Slot 1: 0/0/8/0/0 *Primary LAN/SCSI Card (Core IO board set) 0* • 0/0/8/0/1/0 SCSI C1010 Ultra160 Wide LVD • 0/0/8/0/1/1 SCSI C1010 Ultra160 Wide LVD • 0/0/8/0/4/0 HP A6794A PCI 1000 Base-T	Slot 1: 1/0/8/0/0 A5158A Tachyon TL/TS FCMS
Slot 2: 0/0/10 A5158A Tachyon TL/TS FCMS	Slot 2: 1/0/10
Slot 3: 0/0/12/0/0 A5158A Tachyon TL/TS FCMS	Slot 3: 1/0/12/0/0 A5158A Tachyon TL/TS FCMS
Slot 4: 0/0/14	Slot 4: 1/0/14
Slot 5: 0/0/6/0/0 A5158A Tachyon TL/TS FCMS	Slot 5: 1/0/6/0/0 A5158A Tachyon TL/TS FCMS
Slot 6: 0/0/4	Slot 6: 1/0/4
Slot 7: 0/0/2/0/0 A5158A Tachyon TL/TS FCMS	Slot 7: 1/0/2/0/0 A5158A Tachyon TL/TS FCMS
Slot 8: 0/0/1/0/0	Slot 8: 1/0/1/0/0 *Secondary LAN/SCSI Card (Core IO board set) 1* • 1/0/1/0/1/0 SCSI C1010 Ultra160 Wide LVD • 1/0/1/0/1/1 SCSI C1010 Ultra160 Wide LVD • 1/0/1/0/4/0 HP A6794A PCI 1000 Base-T
0/0 - *GSP/SCSI (Core I/O board set) 0* • 10/100 Base-T mgmt LAN • Remote & Local Consoles • 0/0/0/1 UPS Port (RS232) • 0/0/0/3/0 SCSI C1010 • 0/0/0/3/1 SCSI C1010	1/0 *GSP/SCSI (Core I/O board set) 1* • 10/100 Base-T mgmt LAN • Remote & Local Consoles • 1/0/0/0/1 UPS Port (RS232) • 1/0/0/3/0 SCSI C1010 • 1/0/0/3/1 SCSI C1010

Front Panel Layout			
Core I/O 0	(Removable device bay empty)	1/0/0/3/0.6.0 18.2G HP 18.2GST318404LC	0/0/0/3/0.6.0 18.2G HP 18.2GST318404LC
Core I/O 1		(Internal disk bay empty)	(Internal disk bay empty)

Table A.1

7 Appendix B – Related Documentation

7.1 Additional References

HP Server rp7410 Sweet Spot Verification Technical Server Solution White Paper

HP Server rp7410 Sweet Spot Verification SAP ERP Solution White Paper

HP Server rp7410 Sweet Spot Verification Oracle CRM Solution White Paper