ICS BANKS benchmark on IBM Power Systems

High-watermark performance benchmark project

During April and May 2012, ICS Financial Systems (ICSFS) undertook a performance test jointly with IBM® performance experts from the IBM Montpellier PSSC Customer Center. The purpose of this project was to run a scalability test and to optimize ICS BANKS application for IBM high-end Power Systems™ servers running IBM AIX®. Both ICS BANKS business and data tiers ran in AIX logical partitions and were considered for this optimization effort. The test also validated the use of a virtual network for ICS BANKS presentation and business tiers using the IBM PowerVM® virtualization technology. This solution brief outlines how ICS BANKS can be successfully deployed on IBM Power Systems, the business values of these IBM servers for ICS BANKS and documents the results of this scalability test.

ICS BANKS

ICS (London) was established in London in 1978 as a system integrator and turn-key solutions provider. In 1991, ICS (London) explored changing its business model to become an independent software vendor (ISV). Capitalizing on previous expertise, ICS (London) launched a strategic project for developing a universal banking software application which resulted in the creation of ICS BANKS. In 2004, ICS Financial Systems Ltd. (ICSFS) (www.icsfs.com) emerged from ICS (London) as a leading provider of universal banking software systems focused on the financial industry upon the rapid growth, demand, and maturity of the ICS BANKS software.

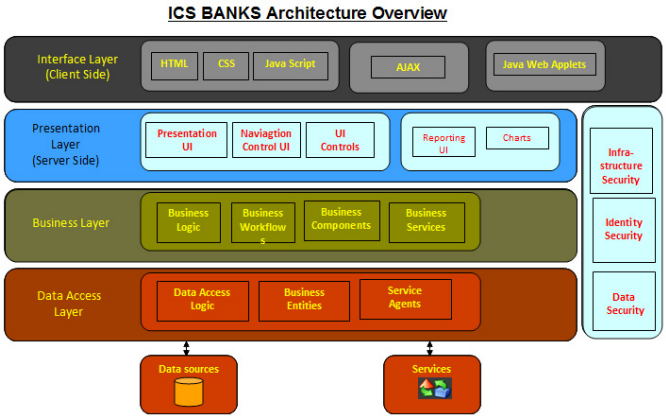
ICS BANKS is a state-of-the-art software that delivers maximum value to banking clients of all sizes. This universal software is a complete suite of banking business modules with a rich sweep of functionality and features addressing business needs foremost, and automating accounting processes as needed, to enhance a customer's business performance. ICS BANKS uses the latest technologies to cover all business areas such as core banking, remittances, trade finance, lending, credit facilities and risk groups, finance leasing, investment, and Islamic banking. The use of the latest technologies to provide availability, scalability, and best performance is one of the goals achieved by implementing ICS BANKS. ICS BANKS is scalable and modular; each of its modules is parameterized to quickly support a client's unique workflow, as many of its modules are designed to stand-alone, as implementation of any module can be separately accomplished. Therefore, each module can be integrated seamlessly with other business modules, on any platform, and can quickly interface with legacy system, and its open architecture capabilities to quickly interface with third-party applications. This design of the ICS BANKS system modules eliminates the need for any additional interface between modules and the core system, and streamlines data flow within the system, providing faster and easy-to-use software and insuring real STP. Finally, ICS BANKS gives the user the facility to deploy modules at any level, whether head office, branch or external delivery channels, such as Internet banking or Kiosks.

ICSFS uses the n-tier architecture in the system construction which consists of:

1. User interface consisting of UI components, data validation, and flow control.

2. Application farm consisting of application business logic and services.

3. Database farm consisting of data models and business data.



ICS BANKS presentation, business and data layers can be deployed on AIX logical partitions.

Smarter Computing applied to ICS BANKS

IBM Power Systems is often a prevalent system used by banks and financial service institutions to support their daily core business IT systems. Performance, innovative and unique technologies, and superior level of support are the necessary requirements that banks and financial services institutions need to run their business-critical applications securely today and to overcome challenges tomorrow.

IBM Power Systems is designed to allow IT organization to efficiently support bank's strategies to capture new market opportunities to comply with international regulations and to make banking processes more efficient. IBM Power Systems enables higher IT agility to successfully align IT with the business strategy.

IBM Power Systems offers a robust framework for the consolidation of business-critical applications requiring high level of scalability and a high level of security. IBM Power Systems represents the opportunity to reduce IT infrastructure cost of ownership by increasing IT efficiency.

Business resilience

Protected against unplanned outage caused by hardware component failure, hardware component error, and transient error, IBM Power Systems enable business continuity by applying robust and simple software architecture blueprints. Successful high availability and disaster recovery strategies are delivered using technical architectures designed to minimize operational risks in an efficient way. Additional costs required to tune and maintain more-complex clustered and multilayered software architecture can be avoided on these highly scalable and resilient servers.

First Failure Data Capture architecture relying on hundreds of thousands of internal probes enables **automatic error detection**. Reboot and retry error detection strategies—synonym of business services interruption and strong dependency on local expertise presence—are therefore avoided.

AIX concurrent update, Live Partition Mobility, PowerVM hypervisor concurrent firmware update and Hot Add and Repair Maintenance of hardware components minimize the need and the impact of planned outage. IBM Power Systems and AIX provides the necessary tooling for system administrators to perform tasks with agility and to maintain the continuity of business services provided with the ICS BANKS application.

Reference: IBM white paper; *POWER7 System RAS*
ibm.com/common/ssi/cgi-bin/ssialias?subtype=WH&infotype=SA&appname=STGE_PO_PO_USEN&htmlfid=POW03056USEN&attachment=POW03056USEN.PDF

Performance and scalability

IBM POWER7® processor-based servers running from 3 GHz to 4.25 GHz and its out-of-order instruction running mode ensures minimum response time and high level of satisfaction for users when processing ICS BANKS business transactions. Each POWER7 processor-based server is capable of four-way simultaneous threading that roughly double the processing power delivered by a monothreaded processor. Thanks to this four-way level of parallelism per core, POWER7 reduces ICS BANKS end of day batch-processing time, and delivers more transactions and supports more user sessions per core.
IBM Power® 795, Power 780, and Power 770 servers can be respectively equipped with a maximum of 64, 96, and 256 cores per server. High number of cores per system and four-way simultaneous threading per core allows supporting the current and future requirements of ICS BANKS customers servicing more than one million of account.

Besides the POWER7 processor performance, IBM Power Systems adopted a very balanced internal architecture for the processors/memory and I/O switch inter-communications that can efficiently use POWER7 high performance and massive level of parallelism. The nonuniform memory access (**NUMA**) architecture ensures linear performance, scalability, and adequacy for application or tier consolidation strategies, and optimizes ICS BANKS database behavior to handle large number of concurrent users.

IBM Power Systems offers the **Capacity on Demand** (CoD) technology where additional processors and memory are preinstalled on shipped systems. These hardware resources can be later temporarily or permanently activated using a software activation key. Consequently, additional hardware resources can be enabled without requiring the local presence on site of IBM experts and without the need of planning for some heavy hardware maintenance operations. The activation of additional on-demand hardware resources is typically used to successfully face peak activity, sudden growth (acquisition), or organic business growth requirements.

Power Systems integrates energy management technologies from its processor, firmware, and PowerVM virtualization to AIX. POWER7 clock speed frequency can increase or decrease based on system workload or thermal conditions. Interestingly, **Dynamic Power Save Favor Performance Mode (DPS-FP)** allows higher clock speed than the nominal frequency. Therefore a Power 750 server can deliver up to 10% more performance using this mode. The DPS-FP mode automatically increases processor clock speed when system is more than 10% busy and otherwise decreases processor clock speed to save energy.

Consolidation

Consolidation is a well known strategy adopted by the banking industry to cut IT costs. IBM Power Systems and its Type1 bare metal virtualization hypervisor (PowerVM) offers a secure and scalable virtualization framework for consolidating ICS BANKS with applications such as enterprise service bus, Internet banking, customer relationship management, or preproduction systems. PowerVM has zero known security vulnerability and hosting virtual servers does not suffer from any hardware limitation that might affect the scalability available on a large system, such as Power 795, Power 780, or Power 770.

PowerVM is a flexible and powerful framework that allows considering different technical architecture options to meets specific ICS BANKS customer operational requirements. As an example, different patterns and resource allocation policies can be applied for business and data tier: **Dedicated shared mode** for ICS BANKS guarantees a dedicated processor capacity for the application and the dispatching of the free processor cycle to other applications only when cycles are idling.

Active Memory Expansion is a one-click technology that can be used to cut by a minimum of 50%, the amount of physical memory used as example for non-critical systems such as preproduction, test, development, UAT applications, and so on.

Virtual shared pools enable Sub-Capacity Licensing counting rules for software depending on the number of cores. It allows a better management of software licensing cost and therefore leads to reduce the costs of consolidated applications with ICS BANKS.

Reference: Server virtualization with PowerVM
ibm.com/systems/power/software/virtualization/

Security

AIX is a mature operating system design to support business-critical application system management. Besides the flexibility provided to perform daily operations on these sensible environments, AIX integrates different technologies that helps to protect ICS BANKS presentation, application, and data tiers against low-level access attempts, such as the ones ran during cyberattacks or by malware.

Trusted logging allows the centralization of application logging files and system audit log on a Virtual I/O Server (VIOS), denying an intruder to hide its actions on the system or on the application middleware.

Trusted execution activates signature for binaries, shared libraries and shell scripts and prevents the execution of modified programs.

`root` UNIX super user can be disabled and its rights can be delegated to different users through the domain role-based access control (RBAC) to allow a secure and audited system management.

AIX provides Access Control List for file system fine-grained management to securely manage the file exchanged with ICS BANKS and external systems.

AIX protects ranges of memory using hardware keys at a kernel-thread level to prevent the operating system from memory corruption attacks.

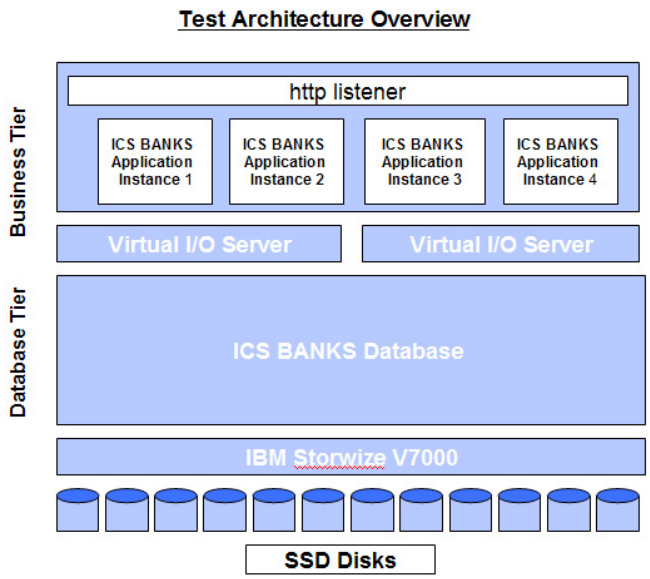
Adequate AIX configuration and auditing capabilities for Payment Card Industry Data Security Standard (PCI DSS) compliance can be easily activated using AIX Security Expert tools. CAPP/EAL4+ mode can be selected at installation time.

IBM PowerVM suffers no security vulnerability.

Architecture

Architecture overview

The ICS BANKS components have been deployed in different virtual servers or logical partitions (LPARs). ICS BANKS application on AIX followed an usual vertical scaling pattern: an HTTP listener received online requests from the injector and dispatched the requests on different instances of ICS BANKS application running in the same AIX partition.



Each instance connects to the same ICS BANKS database. The management of these instances is centralized from a management console. As on IBM Power Systems, hardware resources, such as processor and memory can be dynamically increased or decreased to adjust business needs, and the number of instances can be increased or decreased accordingly. Each instance of the ICS BANKS application manages a pool of connections.

For this test, the network connection between the ICS BANKS application server and the database, and between the ICS BANKS® application servers and the injectors were achieved using a virtual 10 Gigabit adapter. This architecture allows to provision additional virtual server or LPARS to the IBM Power Systems server without the need of hardware maintenance to install the necessary network connection. This test validates the requirement for the VIOS to support a massive workload.

VIOS is a component on IBM Power Systems when using virtual network adapters or virtual disks. Note that dedicated I/O adapters and virtual I/O adapters can be mixed in the same virtual server or LPAR.

Operational model overview

This test validated a full AIX deployment where both application and database tiers are installed on the AIX operating system. Due to third-party middleware availability on the AIX operating system, ICS BANKS application was installed on AIX 6.1 whereas ICS BANKS® database was installed on AIX 7.1 and IBM General Parallel File System (IBM GPFS™) 3.4.

ICS BANKS business tier was deployed on a large IBM Power 780 server equipped with 96 POWER7 processor cores to meet scalability requirements.

ICS BANKS data tier was deployed on an IBM Power 750 server equipped with 32 POWER7 processor cores.

Node name	ICS BANKS application server
	AIX 6.1TL7SP3 Power 780 LPAR Ninety-two POWER7 3.3 GHz processor 900 GB RAM Virtual 10G Ethernet adapter Virtual 1G Etherner adapter Virtual SCSI disks (rootvg) Virtual fiber adapter (planned but unused)

Node name	ICS BANKS database
	AIX 7.1TL1SP3 IBM GPFS 3.4 Power 750 32 POWER7 3.86 GHz processor 512 GB RAM 126 GB internal disks (rootvg) Two Fibre Channel adapters Two 10 GbE network adapters

Running both ICS BANKS business and data tiers on AIX opens the advantage of using IBM PowerVM virtualization to consolidate applications and tiers. The test environment tried to mimic such a consolidated approach by virtualizing network adapters for application tier and still using dedicated adapters for the interconnect network for the data tier.

The virtual I/O component is used to virtualize I/O adapters on the application tier.

Node name	PowerVM Virtual I/O Server
	VIOS 2.2.1.3 Power 780 LPAR Four POWER7 3.86 GHz processor 8 GB RAM Eight 146 GB internal disks One 8 GB Quad Port Fibre Channel adapter One 10 GbE Dual Port network adapter One 1 GbE Dual Port network adapter

IBM Power 750 server

The Power 750 Express server supports up to 32 POWER7 processor cores running at 3.55 GHz and has a maximum memory capacity of 512 GB.

The Power 750 Express server provides great I/O expandability. For example, with 12X-attached I/O drawers, the system can have up to 50 Perjpheral Component Interconnect-X (PCI-X) slots or up to 41 PCI Express (PCIe) slots. This combination can provide over 100 LAN ports or up to 584 disk drives.

IBM Power 780 server

IBM Power 780 supports up to 96 POWER7 processor cores running at 3.44 GHz or up to 64 POWER7 processor cores running at 3.92 GHz. 4 TB of memory can be installed on this system.

Besides higher performance and scalability, the Power 780 server differentiates from the Power 750 server by providing:

- Additional reliability features (redundant service processor, clock failover, active memory mirroring) and higher concurrent repair capabilities.
- Processor and memory capacity on demand.

The Power 780 Express server provides higher I/O expandability. For example, with 12X-attached I/O drawers, the system can have up to 192 PCI-X slots or up to 160 PCIe slots. This combination can provide over 384 LAN ports or up to 1344 disk drives.

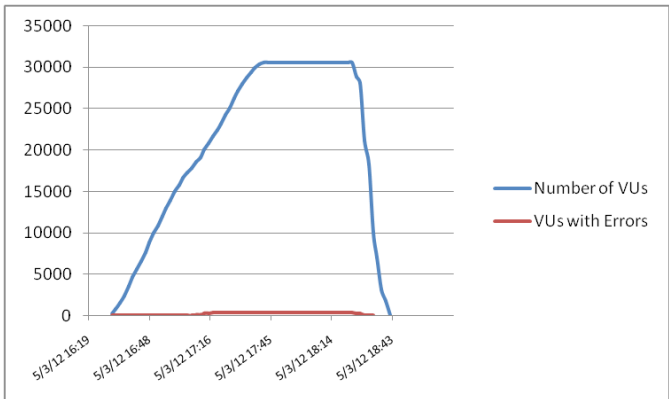
Power 780 is sold by default with a 24x7 with four hour service objective warranty service level – two hours is available in selected cities.

Online test

The purpose of this test was to validate the scalability of ICS BANKS running AIX with a massive number of users. Thirty thousand connected users and 2000 branches were simulated to simulate different kinds of concurrent transactions on the hundred millions of accounts of the ICS BANKS database. Financial and non financial transactions passed by simulated users were: cash withdrawal, cash deposit, opening of different kind of accounts, load disbursement, and cheque clearing.

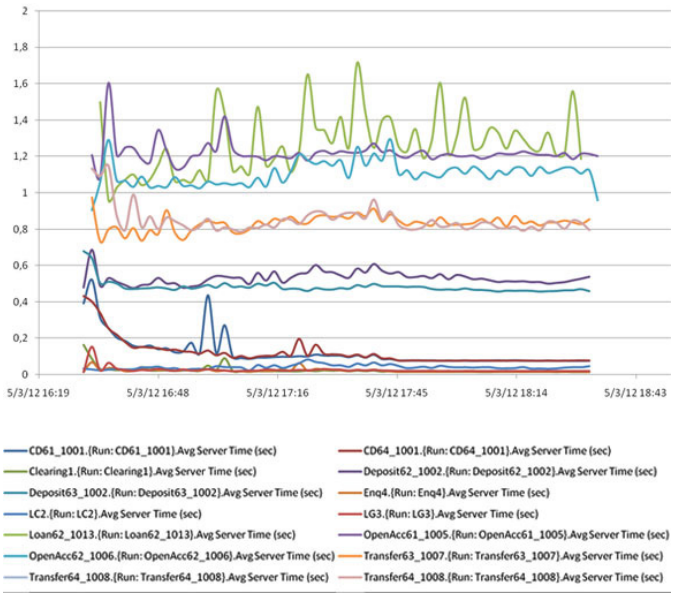
Simultaneously, ICSFS developed a simulator to generate a large amount of electronic transactions: automated teller machine (ATM), point of sale (POS), internet banking system (IBS), and phone banking system (PBS) transactions. Ninety percent of simulated transactions were electronic transactions.

The 30,000 users were gradually connected over a period of one hour. When connected to ICS BANKS application, the user immediately started transactions injection.



During the test, the response time was manually tested by testers to ensure that the measured response time was properly measured.

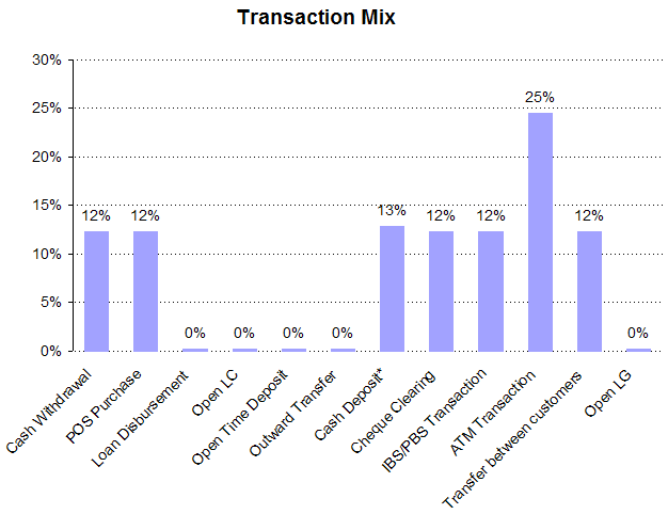
As shown in the following graph, response time for different scripts was stable all along the test and was within the acceptable range for a normal and demand user.



The overall throughput was measured at the ICS BANKS database level with the number of transactions per seconds. The assumption is that there is one commit for each financial transaction. Non financial transaction throughput could not be measured and was calculated from the transaction mix fixed at the injector level.

As observed on the following monitoring graphs, an average of 14,700 transactions per second with stable throughput was achieved during a period of 35 min with 30,000 connected users. The test was stopped as first simulated users stopped injection looping cycle and started to log out.

The following transaction mix was manually checked during the test by querying the ICS BANKS database on the number of passed transactions per type. These queries can be observed on the earlier graph when the number of physical reads increase.

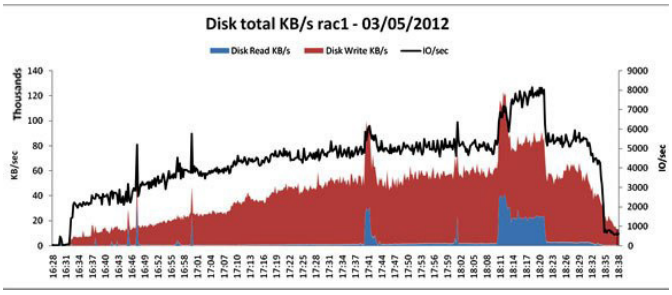


The disk I/O system statistics on one of the ICS BANKS database node reflects the nature of the injection.

The average number of I/O operation per second is roughly 5,000 per second. Peak of read activity happens when ICS BANKS database is queried on the number of passed transactions.

Non-financial transactions use ICS BANKS database cache (in-memory) and consequently, no read activity is observed at the disk level.

Solid-state drive (SSD) disks provided 0 ms wait time at AIX level delivering bleeding edge performance.

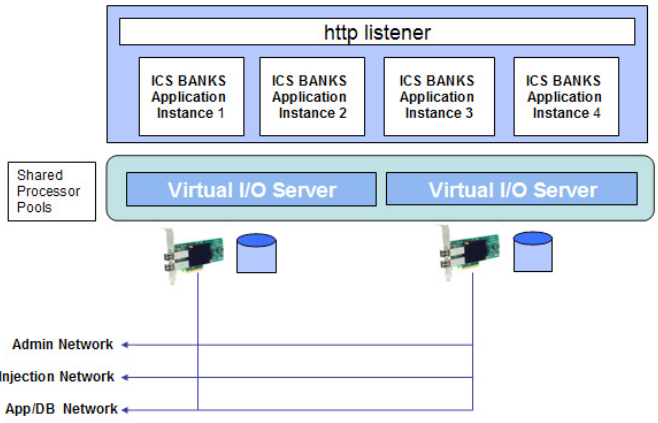


Virtualization

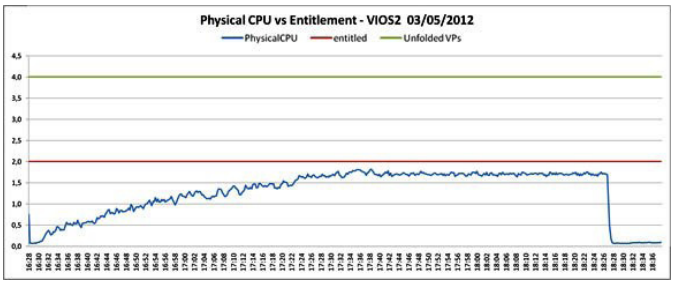
On the ICS BANKS application server, the testing used two VIOS instances running in active/passive resilient architecture. The PowerVM I/O server hosts physical adapters and physical disks that are shared by the different partition in the Power 780 server.

The following virtualized components were included:

- One physical 10 GbE adapter shared by four LPARs.
- Root volume group (rootvg) AIX disks used in particular for AIX installation. During the testing, the ICS BANKS application servers were writing logs on these disks.



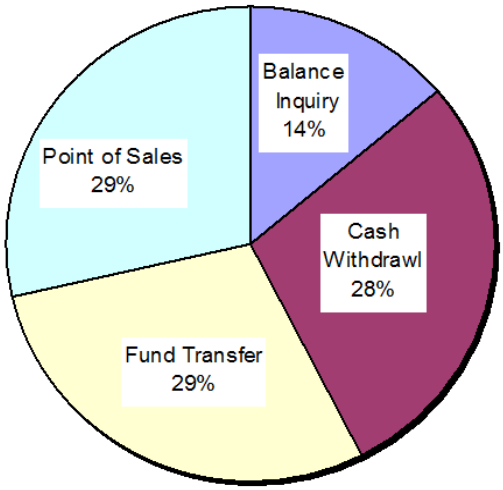
A shared pool was created for them so that each VIOS can use 4 cores, if necessary, when active. In the following figure, you can see that the processor usage for the VIOS instances to support 30,000 users never exceeded 1.7 POWER7 processor core. The virtual server did not use processor cycles available in the shared pools and remained within its capacity entitlement setting (red line).



Electronic channel test

The purpose of this test was to consider only electronic delivery channel and achieve massive high watermark test on lighter transactions. This test only considers the database tier deployed on two IBM Power 750 servers.

The injection consisted of the transaction mix indicated in the following figure:



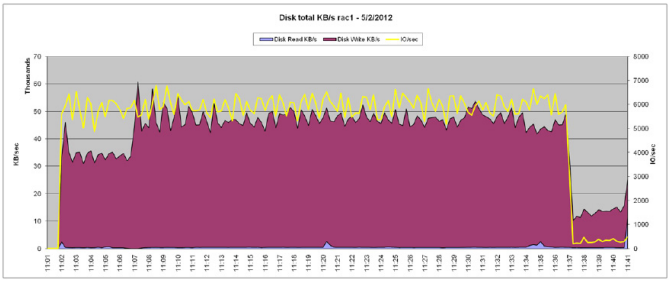
ICSFS verified the number of passed transactions within ICS BANKS every 15 minutes, calculating an average throughput for the number of passed financial transaction of 43,000 transactions per second that sustained for a minimum of 20 min for each test.

The overall throughput that includes non financial transaction can be deduced as the transaction mix is fixed by the injector: 51,431 transactions per second.

This throughput was achieved during a time period of 20 minutes as it can be observed in the following graphs:

The number of passed transactions is very stable all along the 20 minutes.

The monitoring of I/O activity on one of the ICS BANKS database node provides the following graph:



The test team observed a write only activity as the database cache is used for non-financial transaction and a high number of I/O per second in the range of 6000 I/O operations per second (IOPS). The disk wait time is null all along the test.

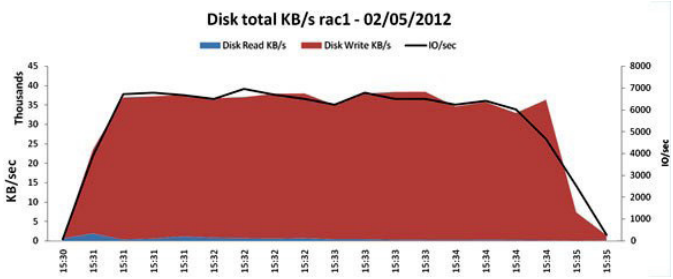
Interest capitalization batch

The purpose of this test was to run the end-of-month capitalization batch on the 100 million accounts database where 10% were interest accounts. The batch is a multiprocessed batch that can take advantage of IBM POWER7 simultaneous multithreading (SMT) technology as each core is able to support slightly more than three batch streams.

10 .5 million accounts were processed in 4 min, delivering an average throughput of 42,000 accounts per second.

The ICS BANKS database statistics reports the throughput with the number of transactions per second as observed in the following graph:

The I/O statistics is depicted in the following graph.



Conclusion

This performance benchmark reflects ICS BANKS high scalability and agility of providing high levels of operational efficiency, meeting end users ever-changing demands and delivering powerful banking solutions on IBM Power Systems. IBM Power Systems coupled with ICS BANKS banking solution shapes an adequate solution for banks and financial institutions looking to implement ambitious business strategies. Though a joint effort, ICSFS and IBM reconfirmed their intent to always deliver an optimized solution to their customers. Offering security, performance and mature integrated virtualization technologies, IBM Power Systems differentiates from competition as a robust framework for efficiently deploying banking applications.

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