



Virtualisation @ HBOS

Table of Contents

Management Summary	1
HBOS plc, a leader in the financial markets	2
HBOS storage requirements	2
HBOS virtualisation strategy spans the system infrastructure	3
Making the business case	4
Areas for further consideration	5

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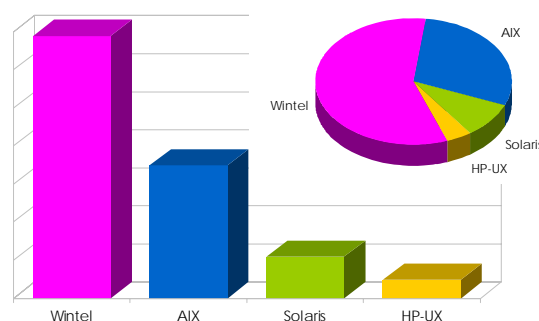
Management Summary

HBOS is continuing its strategy for selective growth in the UK, targeted international expansion, disciplined capital management and rigorous cost control. Information Technology forms the backbone of the bank's systems. The bank has experienced a 63% average annual growth of storage over the last 6 years, reaching 1.7 petabytes. 700 terabytes of storage is required to support over 1,000 open system servers, of which 60% are Windows servers and 40% UNIX servers.

Currently, 90% of the storage operates on high performance tier 1 fibre channel arrays, with 10% of the storage being supported on lower performance tier 2 fibre channel arrays

or on tier 3 SATA arrays. Changing the way in which storage is provisioned will be of great benefit. Service levels can be more effectively formed, enabling resources to be better provisioned, for example, allocating resources for development, pre-production and production environments. Another important gain is achieved by virtualising the application, file and print servers, saving in retesting and possibly rewriting the applications.

Servers Installed



HBOS's virtualisation strategy operates at 4 levels across the system infrastructure. Virtualisation has already been deployed in the local area network (LAN) and wide area network (WAN). The current phase is to extend virtualisation across the servers and storage. Supporting the multiple system images is where Emulex will play a major role. The new HBAs support the virtual server environment and will guarantee the service level through the HBAs. Comprehensive diagnostic functions, coupled with detailed event logging and tracing, provide for fast, efficient SAN troubleshooting.

In making the business case, it is recognised that server virtualisation needs HBA virtualisation to enable effective connectivity between applications running on the servers and the data residing on the storage devices. HBOS provides cost effective solutions which must be secure, trusted, legal and fully supported. With guaranteed performance from the Emulex LightPulse LP11000 series, HBOS can develop its options in setting the service levels and effectively provisioning its system resources.

HBOS plc, a leader in the financial markets

HBOS plc is the result of the merger of Bank of Scotland and Halifax with roots that go back over 300 years. Bank of Scotland had a strong retail banking business in Scotland, together with a successful corporate banking business serving both large and small business customers. Halifax is the largest provider of mortgages and savings in the United Kingdom, offering a growing range of other services and products for the individual - bank accounts, credit cards, unsecured loans, life assurance, pensions, long-term savings and general insurance products.

The bank's continuing strategy is for selective growth in the UK, targeted international expansion, disciplined capital management and rigorous cost control. HBOS has won a 21% share of the mortgage market and has a long term goal to achieve 15-20% market shares in all its key UK retail financial service products. HBOS will develop its strengths of multi-brand and multi-channel distribution to meet its benchmark goals for the insurance and investment markets.

HBOS storage requirements

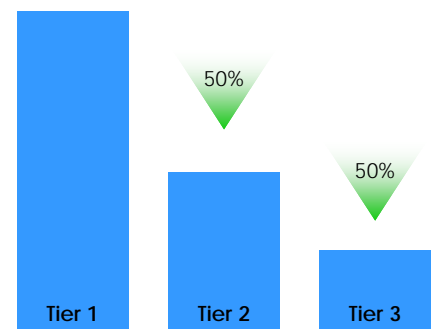
Information Technology forms the backbone of the bank's systems. Managing the increasing volumes of data is a perennial challenge. HBOS has experienced a 63% compound annual growth of storage over the last 6 years. Currently, there is 1.7 petabytes of storage installed across open systems and FICON environments. 700 terabytes of storage is required to support over 1,000 open system servers, of which 60% are Windows servers and 40% UNIX servers. These operate across two SANs on two sites with cross-site back-up.

The volume of storage has built up over the last few years being resident on tier 1 high performance fibre channel arrays. The challenge is to control costs by organising this over lower cost tier 2 fibre channel and tier 3 SATA arrays.

- ❑ 90% of the storage operates on high performance tier 1 fibre channel arrays.
- ❑ 10% of the storage is supported on lower performance tier 2 fibre channel arrays or on tier 3 SATA arrays.

In order to achieve these objectives, HBOS needs its users to undertake a data classification exercise. The end result will enable the data to be provisioned over the most cost effective arrays, with a service level that meets each business units' requirements. This will also address system development, pre-production / testing and production environments.

Relative Cost of Tiered Storage



HBOS virtualisation strategy spans the system infrastructure

Virtualisation offers the opportunity to use computing and network resources more effectively. Applications and users can share devices and resources transparently. As part of HBOS infrastructure developments, virtualisation has been implemented in various ways.

- ❑ Server virtualisation is carried out within the IBM AIX servers, the HP Itanium servers and Windows servers using Microsoft Virtual Server
- ❑ Path management and load balancing across the SANs is carried out with Symantec VERITAS Foundation Suite
- ❑ Virtualisation in the network is already implemented with VPNs and cross-site clustering.

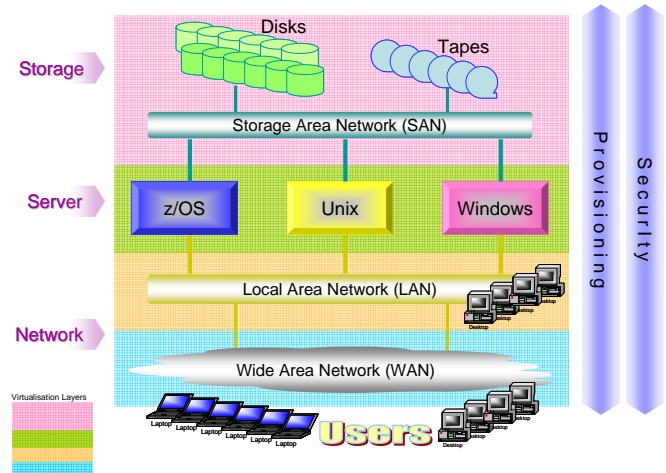
Virtualisation has delivered better utilisation of resources. For example, server utilisation has increased significantly with multiple system images and multiple applications supported on the SQL server farm running on some of the larger Windows servers.

HBOS's virtualisation strategy recognises the three levels of the system infrastructure that must be managed to deliver the services to the users; these are storage, servers and the network. Across these, the infrastructure must be secure and must enable a flexible provisioning regime to meet with the demands of the business units.

HBOS has already implemented virtualisation at the network layer, addressing both LANs and WANs, each having its own operational needs. The current phase is to extend virtualisation across the servers and storage. As a result, there are 4 layers of virtualisation across the system infrastructure.

Supporting the multiple system images is where Emulex will play a major role as servers are virtualised, to provide the connectivity to the data residing on the disk arrays. The new HBAs support the virtual server environment and will guarantee the service level through the HBAs. This is an important issue, especially since multiple system images demand I/O through one physical HBA port. Placing this functionality on the HBA also improves the management of the traffic, with a guaranteed performance through the HBA.

HBOS High Level Virtualisation Strategy



The requirement is to provide reporting based on an awareness of the application, the activity generated and how it is accessing the data on the arrays. Managing the LUNs and supporting the SAN zoning is crucial, as system management must know the frequency of access and the transaction traffic at an application level. The activity profile needs to detail the transactions from the application to the data that serves the application, projecting a host view of how the storage is performing and not just a fabric view. The SAN is now closely scrutinised when there are performance issues - it is no longer just an issue of WAN performance.

Making the business case

There are various dimensions to making the business case. On the one hand, the server virtualisation needs the HBA virtualisation to gain full benefit from better utilisation of the server and the HBA with its SAN connectivity.

Yet there are other factors that play into the overall management case, some of which cannot be fully addressed until new system and management tools are available.

- ❑ The system must be trusted, legal and fully supported. Over 30% of the infrastructure investment budget is spent on keeping the systems current, ensuring the operating environment is using up-to-date versions of hardware and software. This is a high demand on the budget which needs to be addressed with a better set of management tools.
- ❑ Reviewing the service levels may lead to each server not requiring a fully resilient configuration of two HBAs per server. However, this change in practice would reflect developments in setting service levels for users.
- ❑ With a strong philosophy to centralise its systems, HBOS is looking to contain its IT costs while offering a reliable and responsive service to all its business units and employees. To achieve this, the network bandwidth would need to be upgraded by a factor of 4. The associated cost would be offset by the improvements in using tools to balance system and operational management costs.

Areas for further consideration

The organic nature of the business means that flexibility must be embedded in the system philosophy. At the same time, the requirements for security and managing the network must not result in unnecessary overheads that demand system resources.

Locating where storage virtualisation should reside is still an open question.

- ❑ With virtualisation in the SAN fabric, the challenge is managing all the additional appliances. It is believed there is a scalability issue, as each virtualisation appliance tends to manage smaller storage capacities. This can lead to many appliances across a network.
- ❑ With virtualisation in the array, the challenge is to extend file systems dynamically. Currently, the disk arrays can extend volumes, but this needs to include file systems as well.

Changing the way in which storage is provisioned will be of great benefit.

- ❑ Developers share the same arrays as the production work, with the same reliability from the servers. It is anticipated that this could be serviced differently, but would require data classification to be carried out effectively and a better understanding of service levels for the development, pre-production and production environments.
- ❑ Microcode upgrades for the arrays should be tested before they are deployed on live data. Better classification and location of data onto specific arrays would enable practices to develop to upgrade the arrays step by step.
- ❑ Changing the basis of provisioning to a specific array would enable a better organisation of data and enable real cost benefits to be achieved with seamless organisation and movement of data between the three tiers.
- ❑ Virtualising the application, file and print servers would be of great benefit, saving in rewriting the applications.
- ❑ A centralised back-up strategy would ensure consistent standards and practices being deployed across all parts of the business.

Emulex LightPulse LP11000

4Gb/s Fibre Channel PCI-X Host Bus Adapter

- Support for LightPulse Virtual HBA technology
- Full duplex 4Gb/s bandwidth per port
- Sustains up to 115,000 I/Os per second
- End-to-end data protection with hardware parity and CRC support
- Universal boot provides multi-platform support for remote SAN boot
- Enterprise AutoPilot Installer™ simplifies and accelerates HBA installation
- Firmware-based architecture enables HBAs to be updated with new features and functions
- Real time event logging and tracing enables quick diagnosis of SAN problems
- HBAnywhere™ provides centralised management of HBAs anywhere on the SAN

Emulex plays a key role in the evolving system architecture. To gain the maximum benefit from server virtualisation, virtualisation of the HBAs must be delivered. This improves the cost / benefit ratio. Comprehensive diagnostic functions, coupled with detailed event logging and tracing, provide for fast, efficient SAN troubleshooting. And with guaranteed performance from the Emulex LightPulse LP11000 series, HBOS can develop its options in setting the service levels and realigning storage across the three tiers of storage.