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zSTSU October 2004
Advanced Technical Support
SAN File System
Design and V2.1 Update


ABSTRACT
What is this file system for UNIX and Windows systems that exploits the capabilities of a Storage Area Network? This session will answer this question and many more. You will also hear about the features of the latest release (V2.1).



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Agenda

- Introduction
- Server and storage management architecture
- Client architecture
- Administration
- Version 2.1 Enhancements
- Information sources

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File Systems

- Local File System
 - integral part of OS
 - NTFS, FAT, JFS
 - Client: Leo
 - Storage: Leo files
- LAN File Systems
 - use LAN for data
 - NFS, CIFS, AFS, DFS
 - Clients: Leo, Iva, Lou
 - File Servers: File ServerA, File ServerB
 - Storage: Leo/Iva/Lou files
- SAN File Systems
 - use SAN for data
 - SAN File System
 - Clients: Leo, Iva, Lou
 - Storage: Leo/Iva/Lou files
 - Metadata Server
 - Storage Subsystem

SFS lowers storage management costs and enhances productivity by providing:

- Storage consolidation and shared storage
- Space management using quotas and thresholds
- Policy managed storage
- Centralized management – single point of admin control
- Single namespace
- Seamless client access

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SAN File System Quick Introduction

Existing IP Network for Client to Metadata Server Communications

Metadata Server engines

- Metadata Cluster

Storage Area Network

- SAN attached storage
- System Storage Pool
- User Storage Pools (user data storage)

Client OSes: Solaris 9, Red Hat Linux 3, Windows® 2000 & 2003, AIX® 5.x

IO directly from application servers to LUNs for user file data

Metadata:

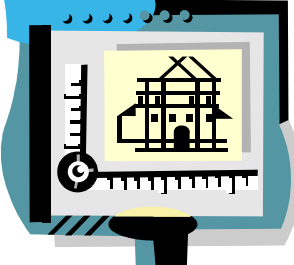
- metadata = control and attribute data about user data
- metadata managed and handled by Metadata Servers
- Out-of-band architecture

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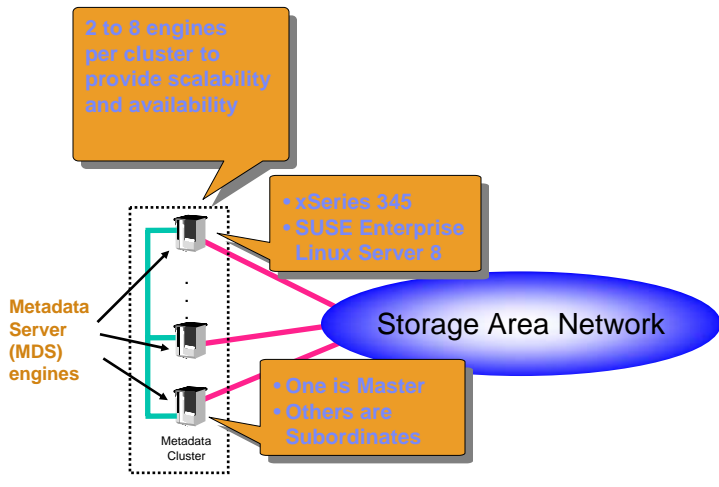
- Introduction
- **Server and storage management architecture**
- Client architecture
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- Version 2.1 Enhancements
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SAN File System Metadata Servers



2 to 8 engines per cluster to provide scalability and availability

- xSeries 345
- SUSE Enterprise Linux Server 9

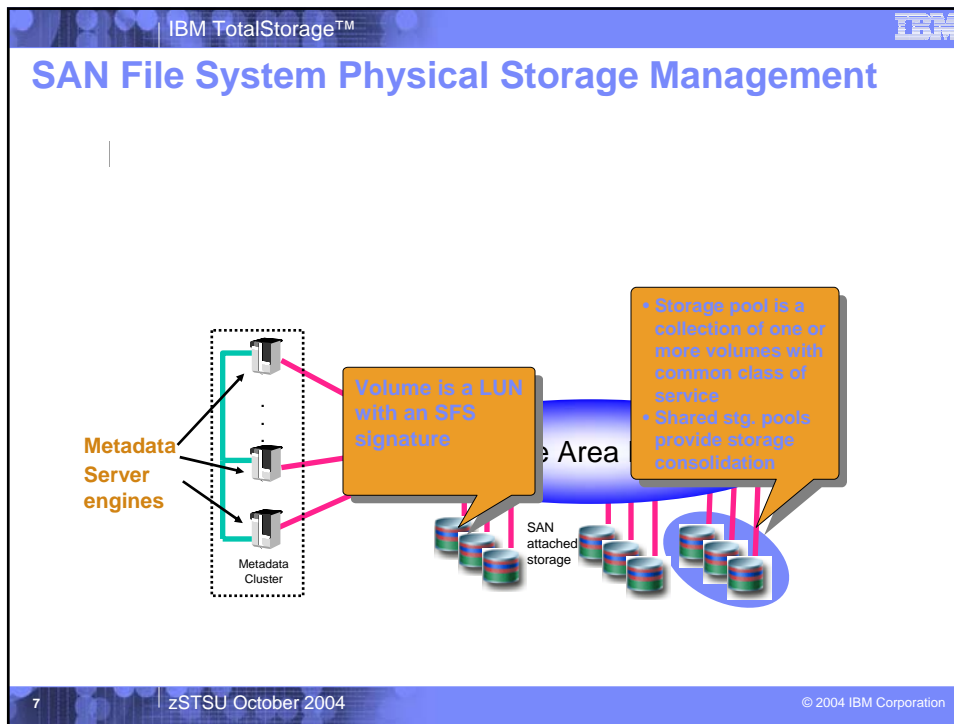
Metadata Server (MDS) engines

Metadata Cluster

Storage Area Network

- One is Master
- Others are Subordinates

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- ## SAN File System storage pools and allocation
- **Storage management feature**
 - Efficient use of storage through consolidation
 - Efficient management of storage
 - Central storage management across many hosts
 - LUN management with little effort and no or minimal appl. disruption
 - **Storage and pool types**
 - System – metadata stored here
 - System metadata – storage pool config., policies, etc.
 - User file metadata – file attributes, etc.
 - User – one or more of these
 - Where user data gets allocated
 - These volumes are read/write from the SFS clients
 - One user pool is default for file allocation
 - **Storage allocation**
 - Master MDS handles cluster-wide partition allocation requests
 - Subordinates handle block level requests for file space
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Storage systems support

- **System Volumes**
 - IBM ESS 800, F20, 750
 - 2.1.1., 2.2.0, 2.3.1, 2.4.0
 - IBM SAN Volume Controller (including all backend devices)
 - V1.1.1, V1.2
 - IBM DS4300 Turbo, DS4400, DS4500
 - Formerly FASiT 600T, 700, 900
 - SATA drives not supported
 - Guidelines:
 - MDS volumes must be same type and model
 - Can have up to 126 dual-path LUNs
- **User Volumes**
 - ESS, DS4000, SVC
 - OEM storage
 - SAN attached
 - device must support SCSI standard for unique device identification
- <http://www-1.ibm.com/servers/storage/support/virtual/sanfs.html>

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SAN File System Physical Storage Management

The diagram illustrates the physical storage management architecture. On the left, a dashed box contains three 'Metadata Server engines' connected to a 'Metadata Cluster'. These servers are connected to a central 'Storage Area Network' (SAN). The SAN is connected to two storage pools: a 'System Storage Pool' and 'User Storage Pools (user data storage)'. The User Storage Pools are shown as multiple 'SAN attached storage' units. A callout box on the right provides details on volume management:

- Add vols. is designed to be**
 - Dynamic
 - Transparent to applications
- Remove volumes is designed to be**
 - Transparent
 - Volume drain - automatic

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Logical Storage Management The global name space

- **Shared storage**
- **Single point of admin control**
- **All clients see all the files**
 - Subject to permission controls
- **Single name space organized with filesets**
 - created by administrator
 - a portion or sub-tree of the entire name space
 - Contents can span storage pools
 - serve as unit of workload for MDSs
 - Requests sent to MDS engine owning the fileset
 - have quotas for space management

```

graph TD
    ROOT([ROOT]) --- FS1([Fileset 1  
(Projects)])
    ROOT --- FS2([Fileset 2  
(Dev)])
    FS1 --- FS3([Fileset 3])
    FS3 --- FS4([Fileset 4])
    FS3 --- FS5([Fileset 5])
    
```

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Using the global name space

- **All clients see the structure**
- **Fileset attach point looks like a normal directory to the client**
- **Clients can now create files and folders**
 - Normal file and directory actions
- **In the beginning, there is the ROOT**
 - A special fileset
 - Can contain other filesets, dirs, and files

```

graph TD
    ROOT([ROOT]) --- Filetxt[File.txt]
    ROOT --- Projects([Projects])
    ROOT --- Dev([Dev])
    Projects --- SANFSProject[SANFS Project]
    SANFSProject --- ProjectPlan[Project Plan]
    SANFSProject --- Tasksdoc[Tasks.doc]
    Projects --- SVCProject[SVCProject]
    SVCProject --- Salesxls[Sales.xls]
    Dev --- Test[Test]
    Test --- Mainc[Main.c]
    Test --- Shopc[Shop.c]
    
```

```

T:\>echo hello > File.txt
T:\>dir
Volume in drive T is SANFS
Volume Serial Number is 98E7-6D3C
Directory of T:
10/01/2003 12:26p <DIR> .
10/01/2003 12:26p <DIR> ..
10/01/2003 12:26p <DIR> Projects
10/01/2003 12:31p <DIR> Dev
10/01/2003 12:22p File.txt
                1 File(s)          8 bytes

                4 Dir(s) 7,568,400,384 bytes free
    
```

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FlashCopy for Filesets

- Point-in-time online FILE-LEVEL snapshot image taken on the SFS fileset level
- Images are placed in the special .flashcopy directory in the fileset's root
- Images are read-only!
- Uses copy-on-write mechanism
 - Source data and FlashCopy images share the same data blocks until write/change on source data occurs.
 - Space efficient
- Up to 32 images
- Fast revert of an image – replaces current fileset contents

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Policy Management

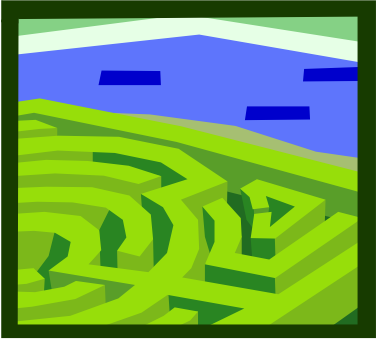
- Storage and file management feature
 - Designed to provide automatic file allocation
- Policy-based management uses policy sets or policies
- A policy is an ordered list of rules
 - Multiple policies can be stored but only one is active
 - Apply across the cluster
- Rules and how are they used
 - Rules determine which storage pool each file is automatically allocated to
 - File allocation to storage based on business requirements
 - Storage pools may have different service characteristics
 - Files in same directory/folder may be allocated to different storage pools
 - Rules can test file attributes: fileset, file names, extensions, dates
 - Rules use SQL-like language
- Placement only enforced at file creation time

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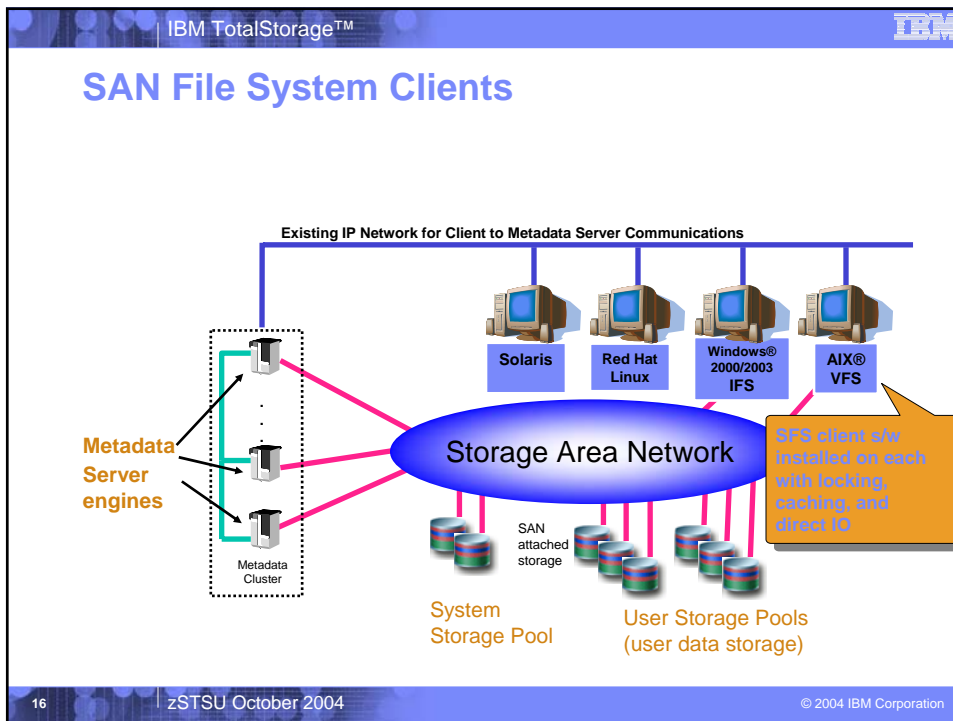
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- Server and storage management architecture
- **Client architecture**
- Administration
- Version 2.1 Enhancements
- Information sources



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SFS supported clients

- AIX 5.1 (32 bit only)
- AIX 5.2 (32 and 64 bit)
- AIX 5.3 (32 and 64 bit)
- Red Hat Enterprise Linux 3.0 (2.4.21-9.6) for x86 architecture
- Sun Solaris 9 (64 bit only)
- Windows 2000 Server, SP 4 or higher
- Windows 2000 Advanced Server, SP 4 or higher
- Windows Server 2003, Standard & Enterprise editions
- More coming....

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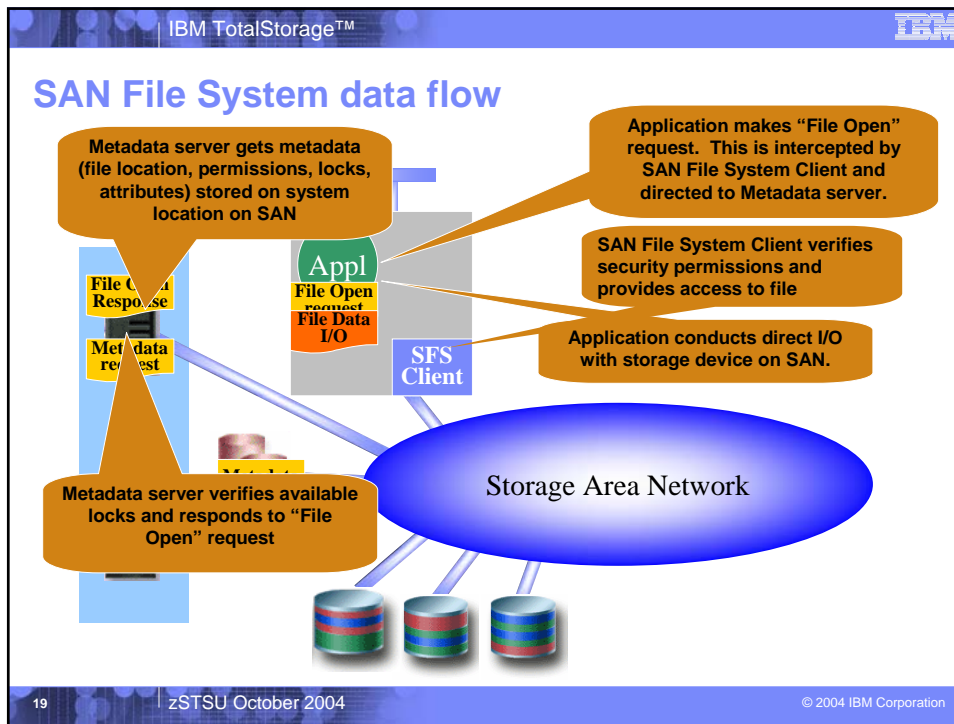
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Client Architecture

- **Client State Manager**
 - provides SFS protocol support
 - provides caching of metadata
- **SFS design**
 - provides transparent interaction with Metadata servers
 - allows applications to interact with it as a native file system through VFS/IFS
- **Direct (non-cached) I/O support**
- **Native O.S. Virtual Memory Manager & Device Drivers used**

The diagram illustrates the Client Architecture, divided into User Space and Kernel Space. In the User Space, Applications interact with the VFS/IFS layer. The VFS/IFS layer is connected to the Client State Manager in the Kernel Space. The Client State Manager is also connected to the Device Driver in the Kernel Space. The Device Driver is connected to the Server via the ST Protocol. A Messaging component is also shown in the Kernel Space, connected to the Client State Manager and the ST Protocol.

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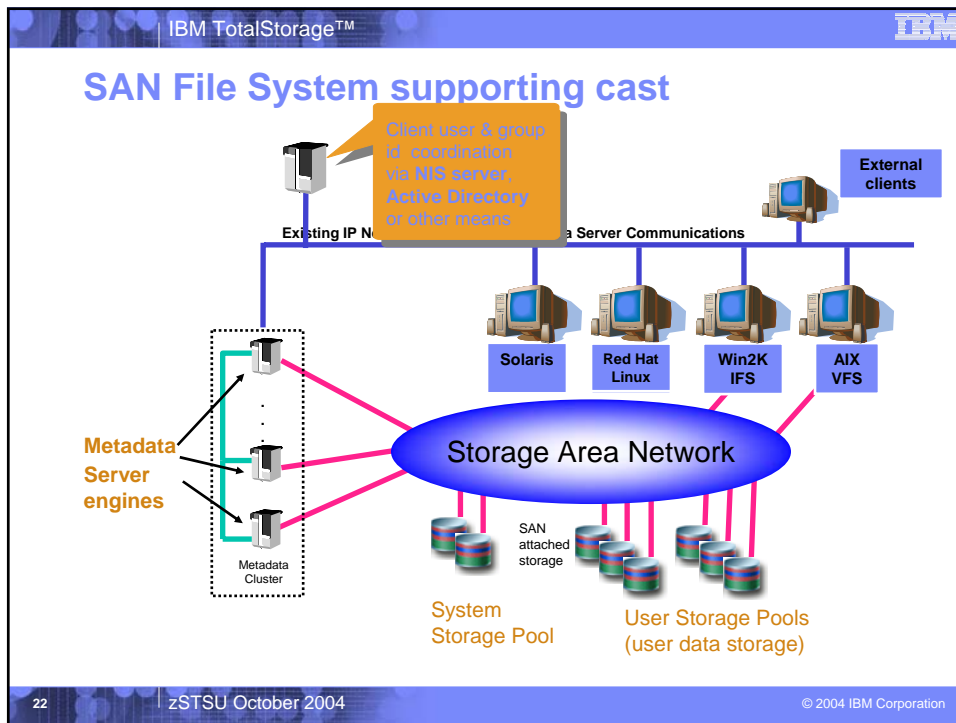
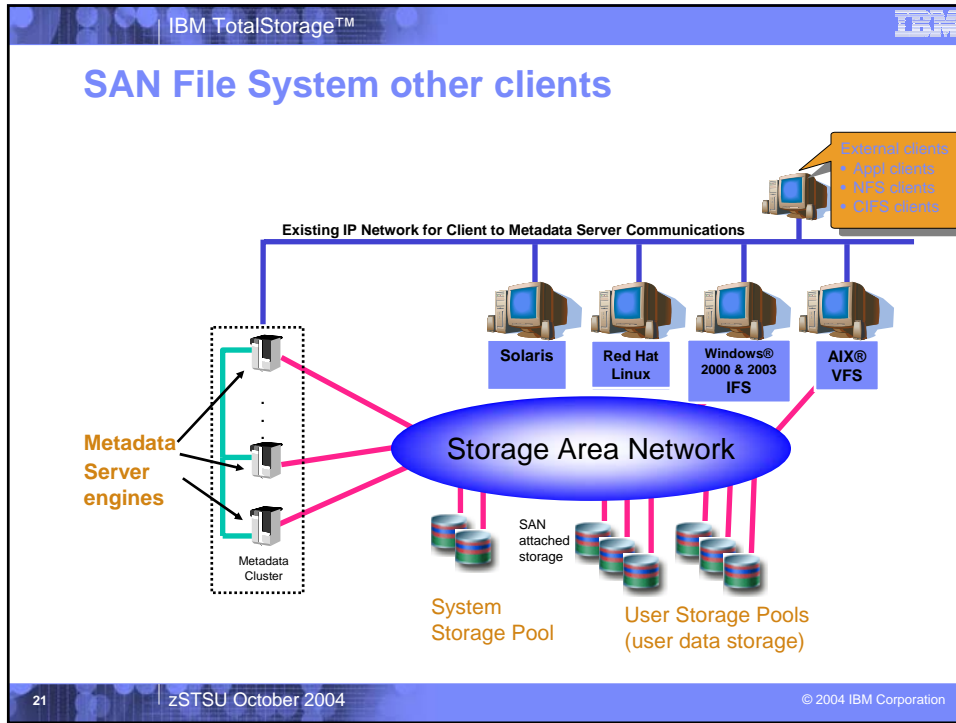
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- ### SAN File System on clients
- **SAN File System for UNIX clients**
 - Global name space appears as new UNIX file system
 - VFS volume properties supported include:
 - Standard permission semantics (owner/group/other)
 - **SAN File System for Windows**
 - SAN File System appears as new drive letter
 - IFS volume properties supported include:
 - Full NTFS ACLs
 - NTFS-like files with some feature exceptions
 - **Permissions depend on file's "birthplace"**
 - Unix or Windows domain determines file access permissions
 - Full file access permissions support provided within birthplace domain
 - **Root/Administrator squashing**
 - Exception for privileged clients
- IBM TotalStorage™ logo is visible in the top left and right corners of the slide.

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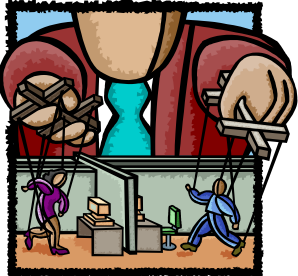
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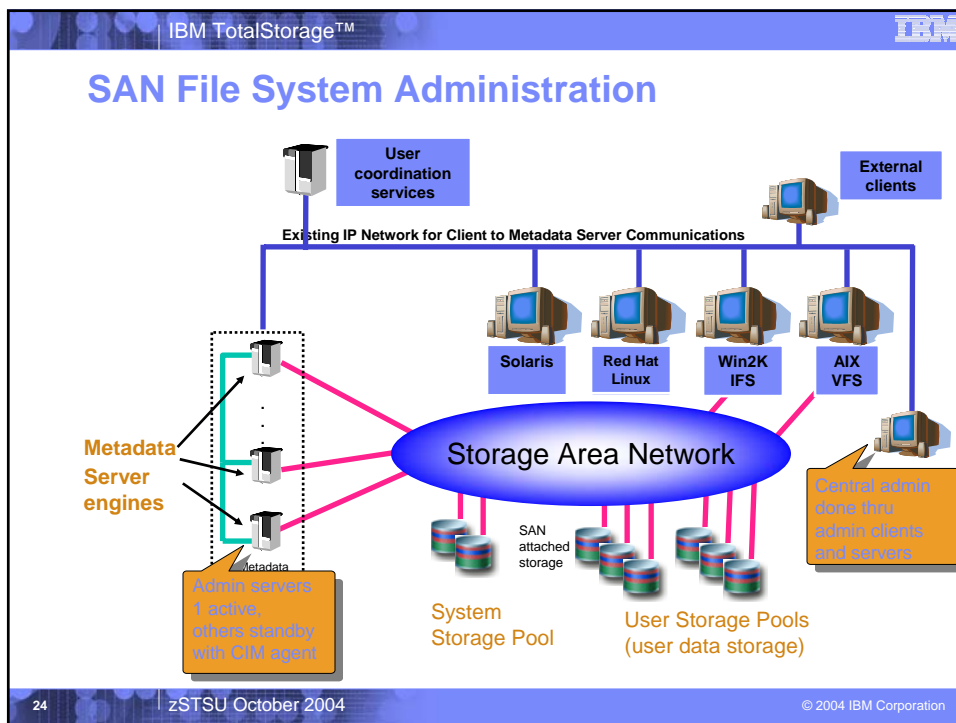
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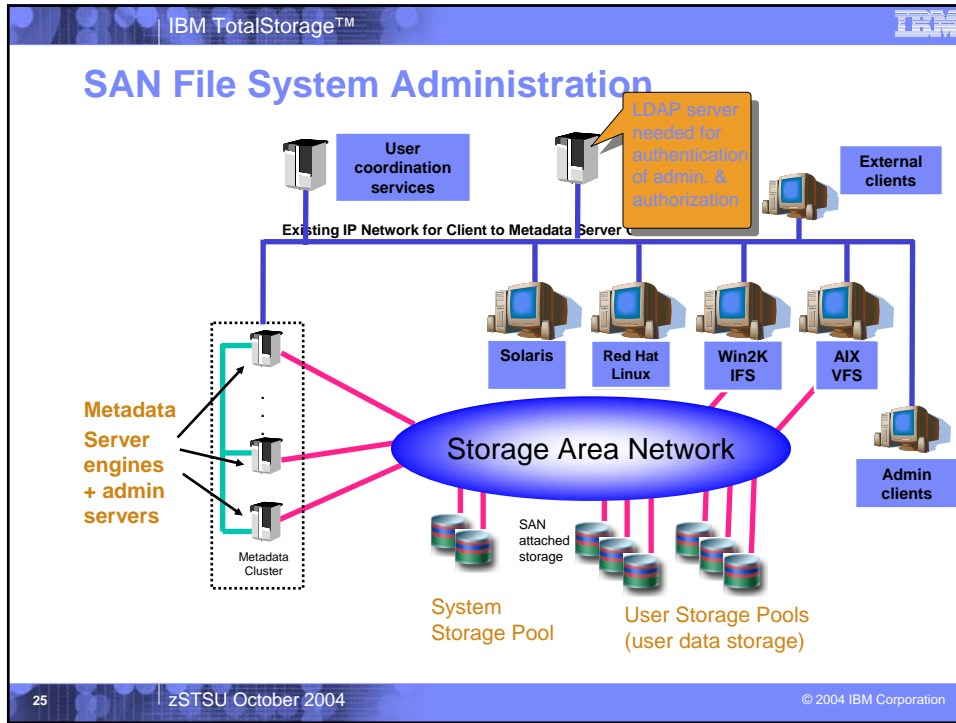
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Agenda


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- Client architecture
- Administration
- **Version 2.1 Enhancements**
- Information sources

The slide features a 3D illustration of a yellow and red Formula 1 race car on the right side.

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SAN File System V2.1 Highlights

- **Additional clients and additional storage support**
 - already covered
- **Functional enhancements**
 - Named Pipes (FIFO file objects)
 - OpLocks now fully supported on Windows
 - NLS improvements
 - Additional enhancements in backup section
- **SAN configuration changes**
- **Availability enhancements**

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SAN Configuration Changes or Flexible SAN

- **Relaxation of SFS SAN configuration requirements**
 - Metadata Servers no longer need to see user data LUNs
 - V1.1 SAN configurations still supported
- **Clients need only see the data LUNs they access**
 - V2.1 adds functions to make non-uniform configurations manageable
- **User data LUN access via clients for admin. commands**
 - All user data LUN operations are coordinated by the metadata server cluster but performed on one or more clients.
 - Administrator must specify a connected client to perform data LUN operations.

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Uniform SAN File System configuration

- All clients can access all user volumes used by SAN FS
- Requirement in V1.1, still supported in V2.1
 - all storage devices must be supported by all clients (OS, HBAs etc)
 - for both Windows and UNIX clients, all storage devices must allow heterogeneous client access
 - Example: ESS does, FASiT does not
 - limits total size of SAN File System

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Non-uniform SAN File System configuration

- Customers can choose how to configure user data LUNs and access within the SAN
- Only SFS clients requiring or supporting access have visibility to each data LUN
 - creates "subsets" of access

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Flexible SAN benefits

- **More scalable**
 - Metadata Servers and clients only access LUNs they need to
 - LUN “ceilings” not likely to be reached
Metadata server only accesses System Pool volumes
 - More LUNs supported for entire SAN File System
 - total number of volumes only limited by client OS support
- **Easier to meet heterogeneous support constraints**
 - Can avoid unsupported combinations (e.g. ESS and EMC multipath)
 - Clients not restricted to “lowest common denominator” of support
- **More flexible and secure**
 - Lets SFS adapt to the customer’s desired zoning/LUN masking
 - Volumes not visible to clients that don’t need access
 - Can make volumes larger non-disruptively


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SFS V2.1 High Availability features

- **Non-disruptive fileset movement**
 - Can be manually or automatically initiated
 - Filesets (workload) re-distributed to remaining MDSs
 - Applications will see I/O pause but not errors in most cases
 - Much faster than V1.1
- **Autorestart capability**
 - attempts to restart MDS process or reboot engine to minimize outage time
 - uses watchdog processes and exploits RSA card capabilities
- **All Metadata servers continually check availability of each other with a heartbeat**


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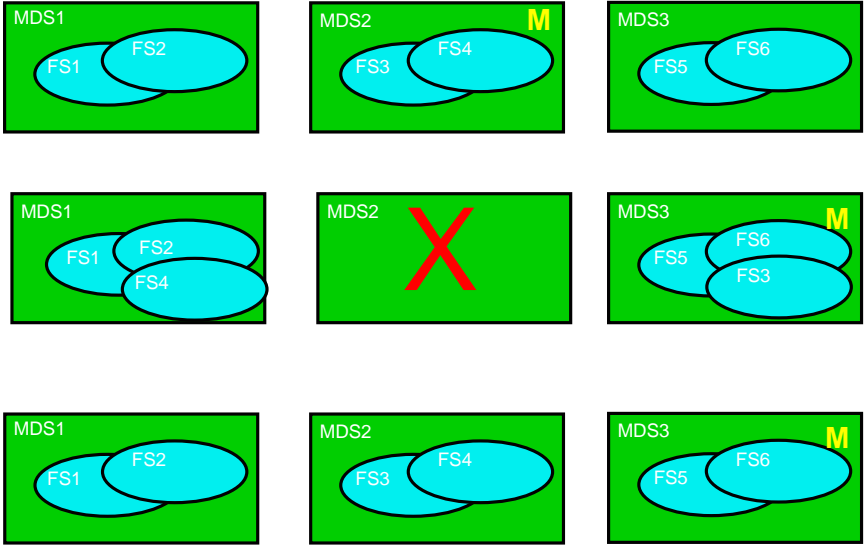
HA features – MDS failover and fail-back

- **If heartbeat is not received in 20 seconds, failover process starts**
 - software error which doesn't recover in 20 seconds
 - engine OS or hardware failure
 - network failure
 - unrecoverable MDS crash
- **Filesets owned by failed server are redistributed automatically**
 - If spare (N+1) server is available, all filesets are moved to the spare.
 - Otherwise, distributed round-robin to servers, with load balancing
 - New master MDS elected if required
- **On fail-back**
 - Static filesets are automatically reclaimed after restart
 - Dynamic filesets may get redistributed if required for load balancing
 - If only dynamic, then filesets are re-balanced
 - If mixed – filesets may not end up re-balanced, therefore avoid mixed


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Failover Example




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- **Information sources**




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SAN File System support & information sources

- **SAN File System home page for overview, protocol spec, tutorial, and more:**
<http://www.storage.ibm.com/software/virtualization/sfs/>
- **SAN File System support page:**
<http://www-1.ibm.com/servers/storage/support/virtual/4146.html>
- **Redbooks/redpapers**
 - Introducing the SAN File System - SG24-7057
 - Virtualization in a SAN – REDP3633
- **Systems Journal article – “IBM Storage Tank—A heterogeneous scalable SAN file system”**
<http://www.research.ibm.com/journal/sj/422/menon.pdf>
- **ITS Education – “Planning and Implementing the IBM SAN File System”**
2.5 day customer class - description, schedule, and more on these sites:
 - US Class: http://www-306.ibm.com/services/learning/ites.wss?pageType=course_description&courseCode=SN840&country=us&language=en
 - Montpellier (France) Class: [http://www-5.ibm.com/services/learning/fr-ta-iris.nsf/\(ExtCourseNr\)/SNM78AFR](http://www-5.ibm.com/services/learning/fr-ta-iris.nsf/(ExtCourseNr)/SNM78AFR)




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SAN File System solution assurance and support

- **Solution Assurance Reviews:**
 - Presale and Preinstallation Soln. Assurance Reviews required
 - Solution assurance documents and reviews are your helpers
 - Presale helps you develop a solution proposal that meets cust. requirements
 - Preinstallation helps assure the solution can be installed without problems
 - Expert Solution Assurance Reviews are encouraged and easily scheduled
 - All of this leads to a satisfied SAN File System customer
 - Scheduling and Solution Assurance docs. available on the web:
 - IBM: <http://w3-1.ibm.com/support/assure/assur30i.nsf/Web/SA>
 - Business Partner: <http://partners.boulder.ibm.com>
- **IBM field and Business Partner technical support**
 - SFS Capacity Planning white paper available through TechDocs
<http://w3-1.ibm.com/support/techdocs/atmastr.nsf/WebIndex/WP100411>
 - This should be used to determine the number of metadata servers needed
 - SFS Capacity Planning process in Presale S.A. Checklist
 - IBM WWQA/ViewBlue & QBucket: w3.viewblue.ibm.com
 - Business Partner support: www.ibmink.ibm.com + Service Information Search (SIS) function


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Questions?



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Backup slides

- The following can be used to answer questions and as reference

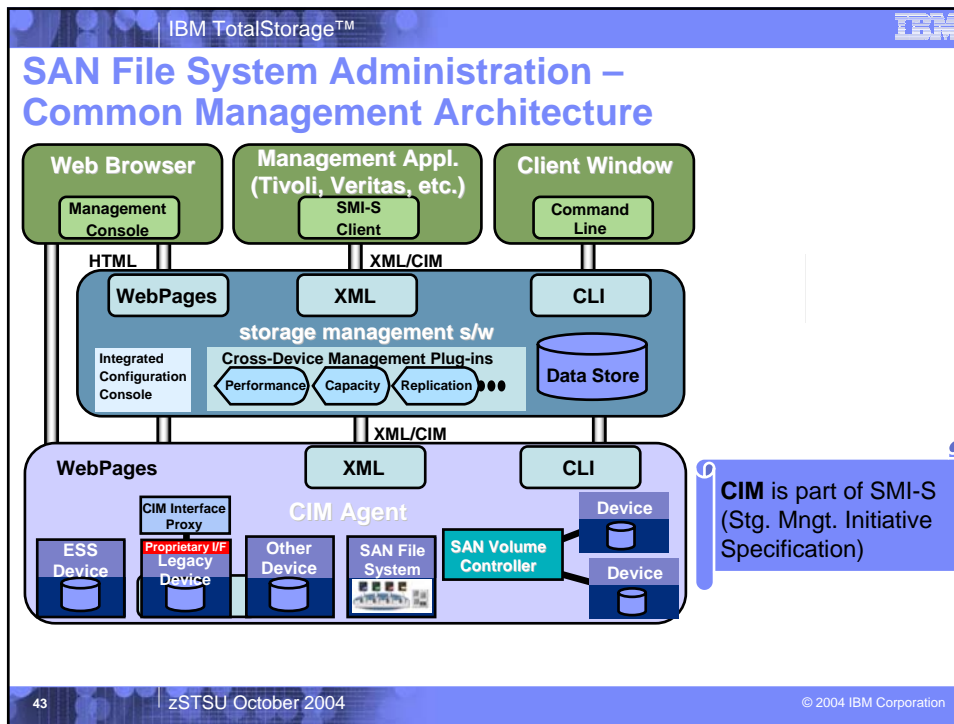
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Backup and restore summary

- **File-oriented backup and restore**
 - Use existing backup tools (Legato, Veritas, Tivoli, tar, cpio etc.)
 - Back up
 - Live files and directories
 - FlashCopy® images of any or all filesets in the file system
 - Back up and recover files on client of their “birthplace”
- **LUN-oriented backup and restore**
 - Must include all LUNs in all pools (user and system pools)
 - Perform block level backup of all SAN F.S. volumes using hardware based Advanced Functions (FlashCopy or PPRC)
 - Ability to flush I/O and temporarily quiesce the servers provided

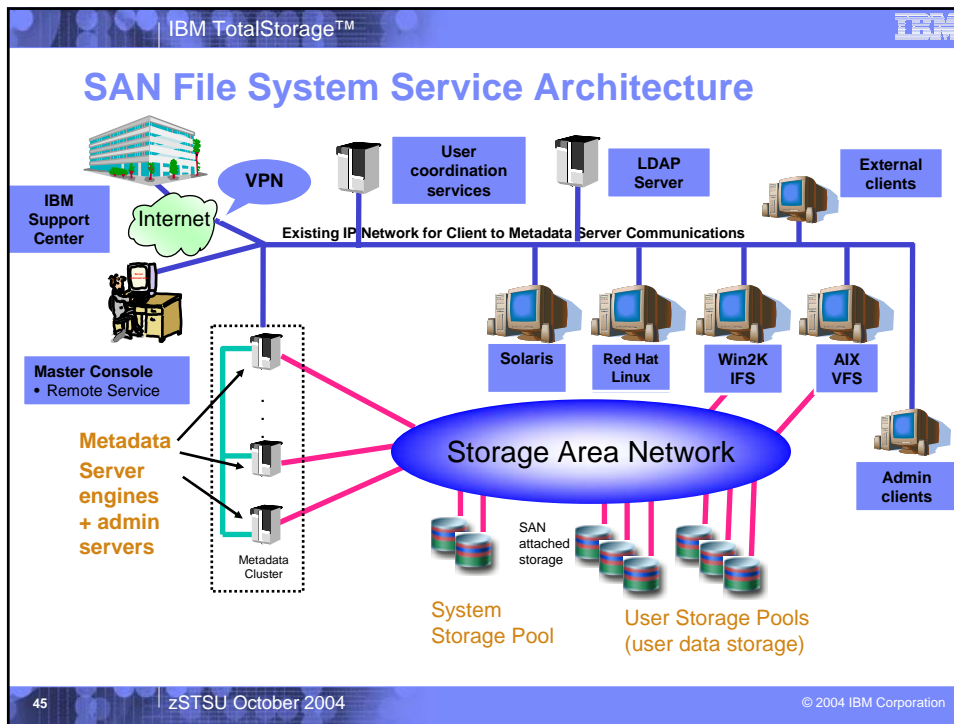
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LDAP server use and requirements

- **Used for SFS administration sessions**
 - Authentication
 - Authorization
- **Tested LDAP servers include:**
 - IBM Directory, OpenLDAP, Windows Active Directory, IBM SecureWay
- **Four LDAP roles are required for SAN FS:**
 - Administrator
 - Monitor
 - Backup
 - Operator
- **LDAP server is a prerequisite**

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- ## Master Console prerequisites
- **Hardware (xSeries 305 or equivalent) – Requirements:**
 - one 2.6 GHz (minimum) processor
 - 1 GB memory (minimum)
 - two 40GB IDE hard drives (minimum)
 - two Gb Ethernet ports
 - two 2Gb HBA ports (QLogic 2340 or 2342)
 - CD-ROM
 - keyboard, monitor, mouse
 - **Software**
 - MS Windows 2000 Server w/Service Pack 4
 - Antivirus software
 - MS Windows IE 6.0
 - J2SE Java Runtime Environment (JRE) 1.4.2
- The slide includes the number "46" in the bottom left, "zSTSU October 2004" in the bottom center, and "© 2004 IBM Corporation" in the bottom right.

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Master Console software

- IBM Tivoli Bonus Pack for SAN Management
- FAStT Storage Manager
- IBM DB2
- IBM Director
- PuTTY telnet/SSH package
- Driver for the QLogic 2342 HBA
- VPN Connection Manager
- SAN Volume Controller Console


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Client — Added client capabilities

- **FIFO file objects on UNIX**
 - FIFO objects can be created and used on Unix clients
 - A FIFO (aka Named Pipe) is a file system object used to queue data between processes.
 - FIFO objects are visible on all clients, including Windows, subject to security
 - FIFO data is client-local; data written on one client not distributed to others
- **OpLocks now fully supported on Windows**
 - Opportunistic Locks (OpLocks) is the optional distributed locking protocol implemented by CIFS
 - Reduces network traffic and improves performance when SANFS is exported from Windows clients as CIFS volume
 - Behavior matches Windows NTFS OpLocks


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National Language Support

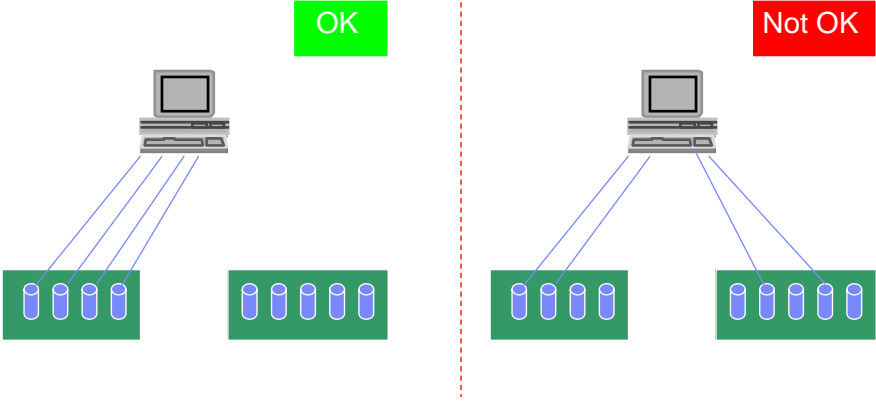
- **SAN FS object names (pools, volumes, etc) can now be in any ICU language and region combination listed at: <http://oss.software.ibm.com/cgi-bin/icu/lx>**
 - Note on fileset names – policies must be in 7-bit ASCII
 - ICU is International Components for Unicode
- **Clients can be in different languages**
 - But may see unintelligible file names if different languages used
- **Administrative language either English (en_US) or Japanese (ja_JP)**

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Client Storage Rules

- **Client must see either all or no volumes in a storage pool**
 - MDS checks for incomplete storage pool access when client connects




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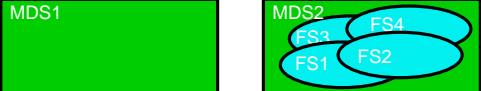
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Non-disruptive fileset movement: Scheduled maintenance

Before




`setfilesetserver -server MDS2 FS1 FS2`



Take MDS1 down for maintenance

After maintenance, `setfilesetserver -server MDS1 FS1 FS2`



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