Tape Library Virtualization

Based on IEEE Standard 1244

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"Tape and media management is starting to become a problem in the distributed space, and customer requirements are extending beyond the simple tools available in the backup products today."

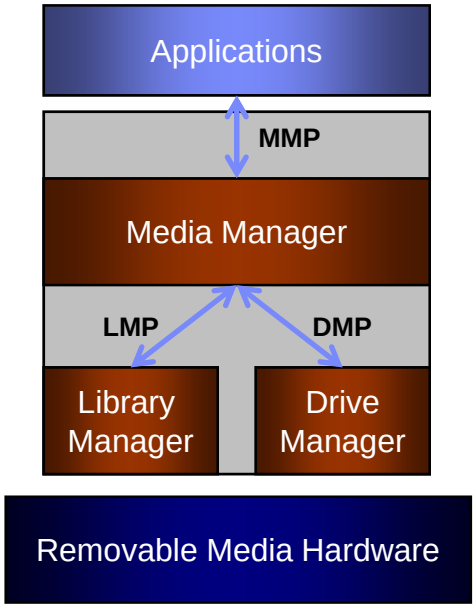
Source: Gartner (2003)

"Dynamic device sharing capabilities replace the practice of each backup server owning its own devices and support dynamic assignment of specific drives to applications as they are needed."

Source: Gartner (2003)

IEEE Standard 1244

IEEE Standard 1244 for Media Management Systems



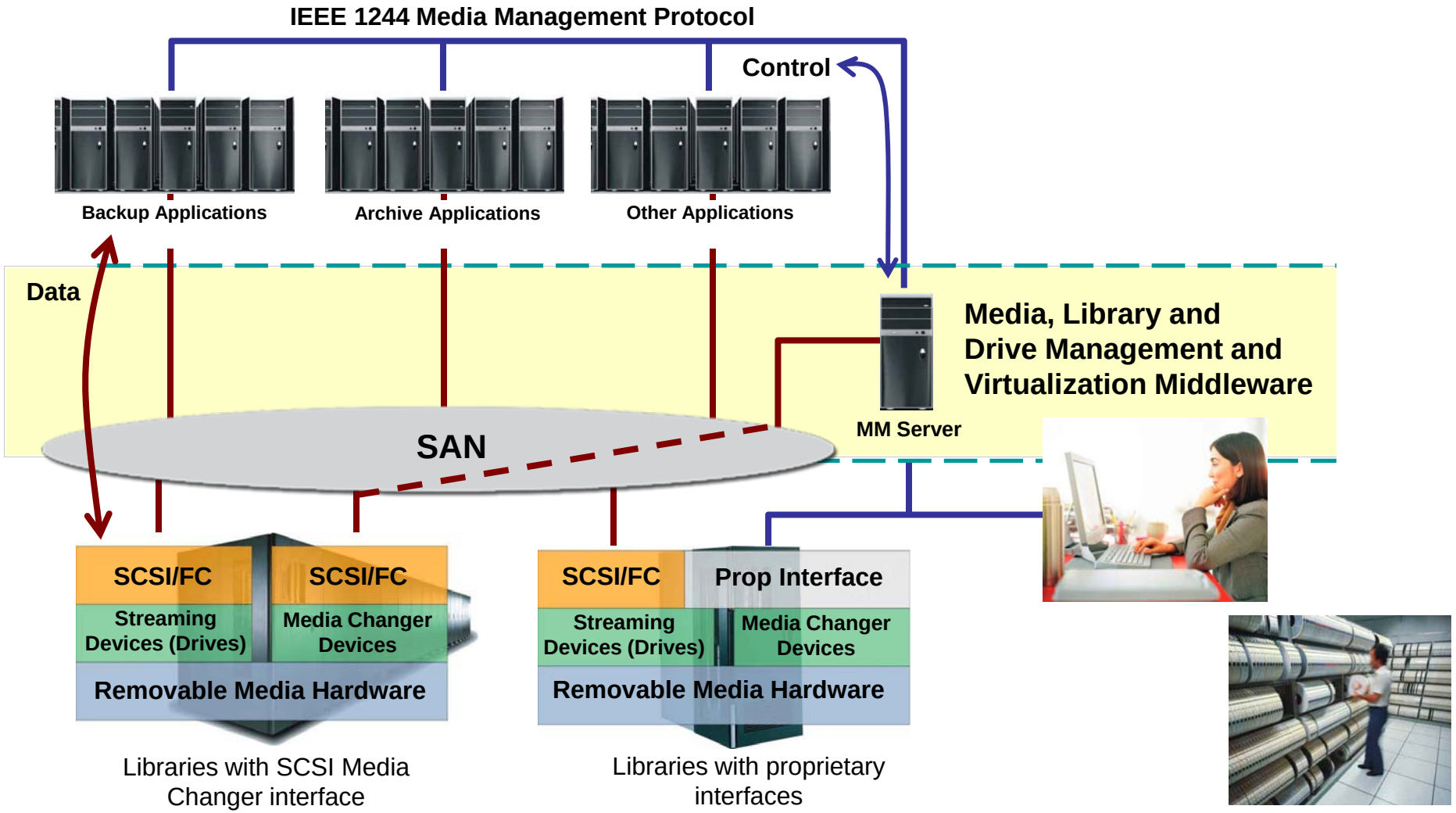
Data Model (IEEE 1244.1)

- Defines a set of objects, their attributes and their relations
- Extends standard relational model by allowing the addition of new attributes to objects
- Allows to integrate every kind of removable media (Tape, CD, DVD, MO, etc.)

MMP: Media Management Protocol (IEEE 1244.3)
LMP: Library Management Protocol (IEEE 1244.4)
DMP: Drive Management Protocol (IEEE 1244.5)

- Asynchronous exchange of text messages over TCP/IP connection (like http, ftp, etc.)
- Commands address the specific needs of media-, library and drive management
- Powerful language

IEEE 1244 Middleware

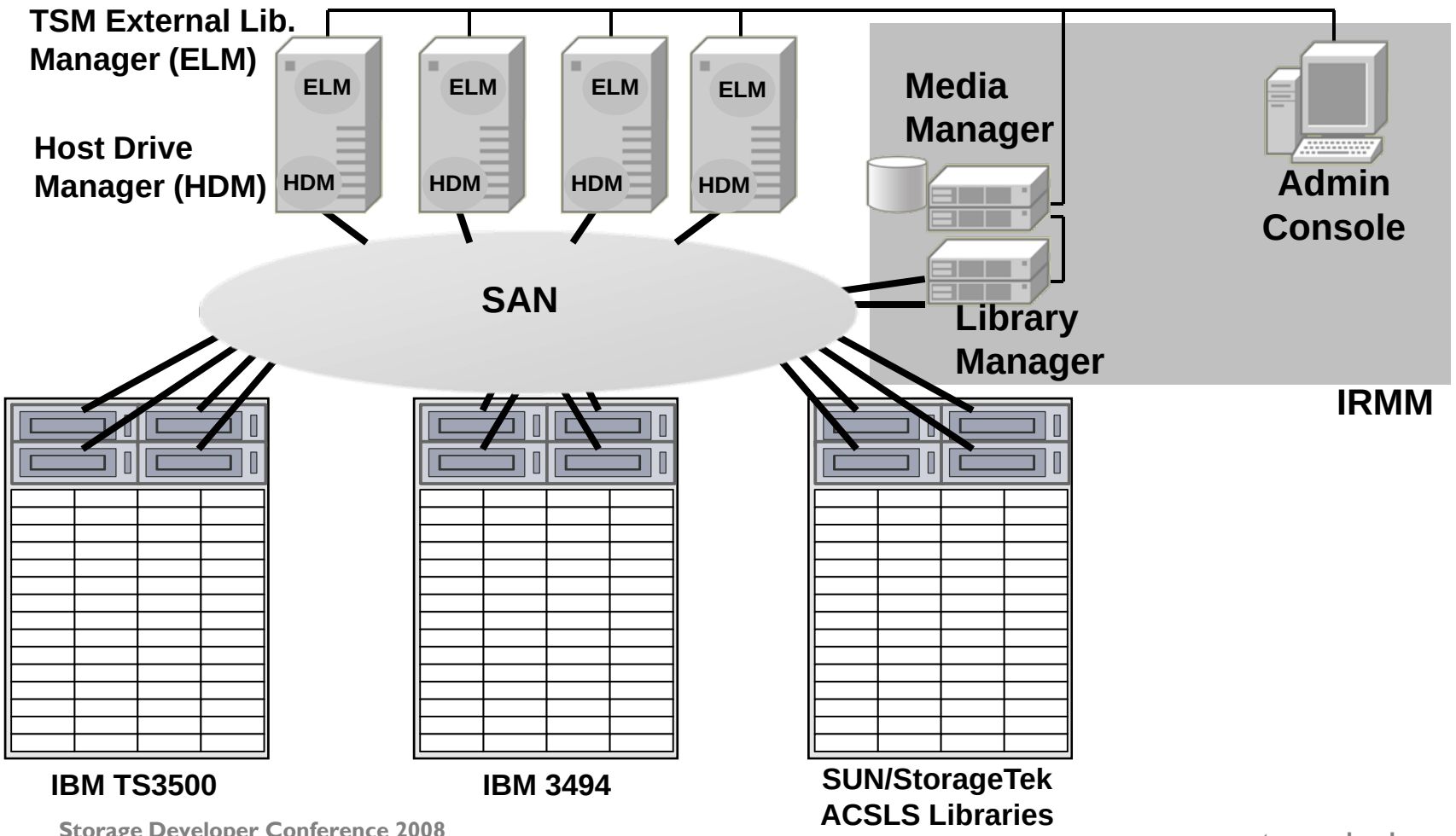


Libraries with SCSI Media Changer interface

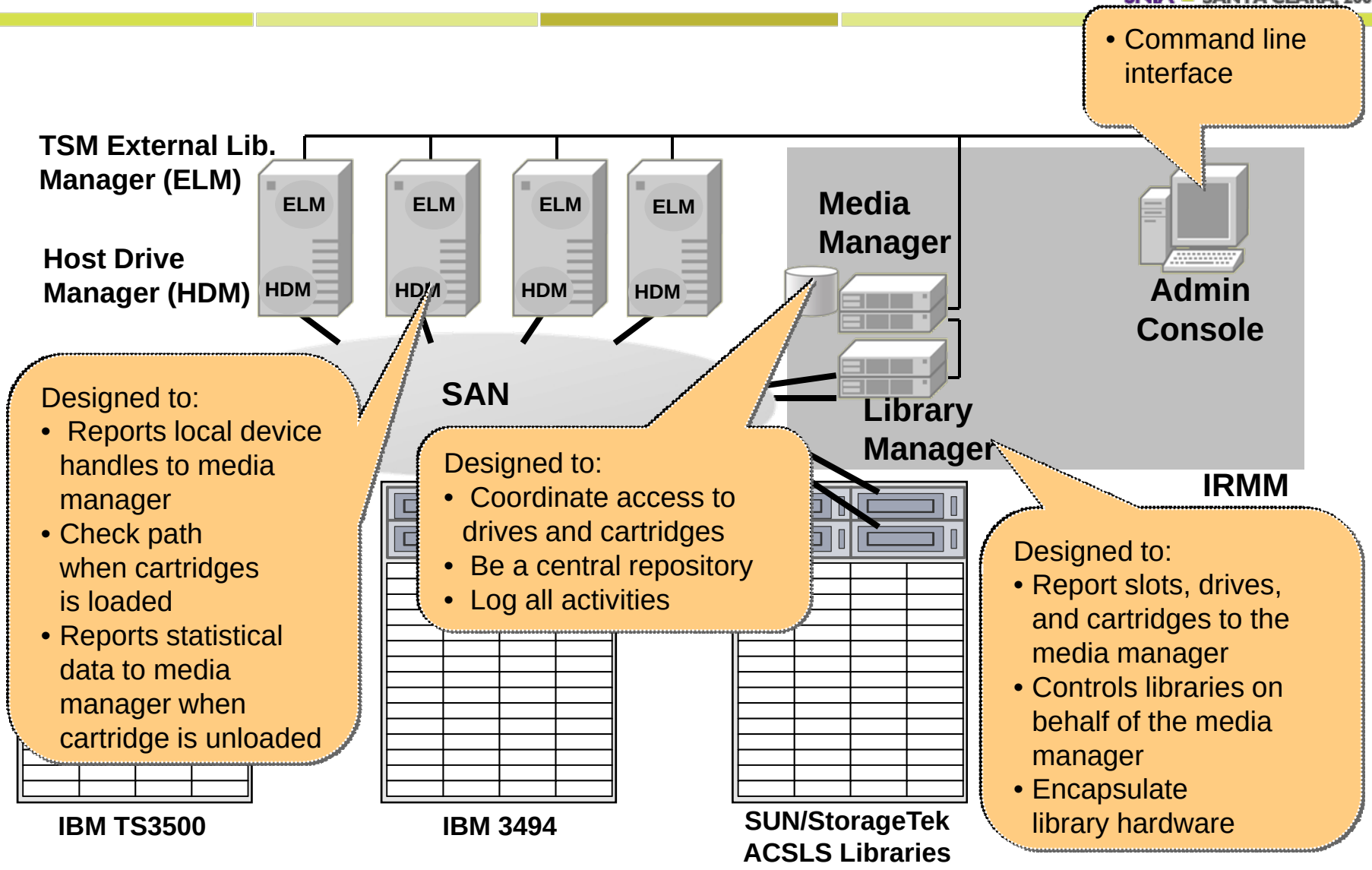
Libraries with proprietary interfaces

MMS Architecture

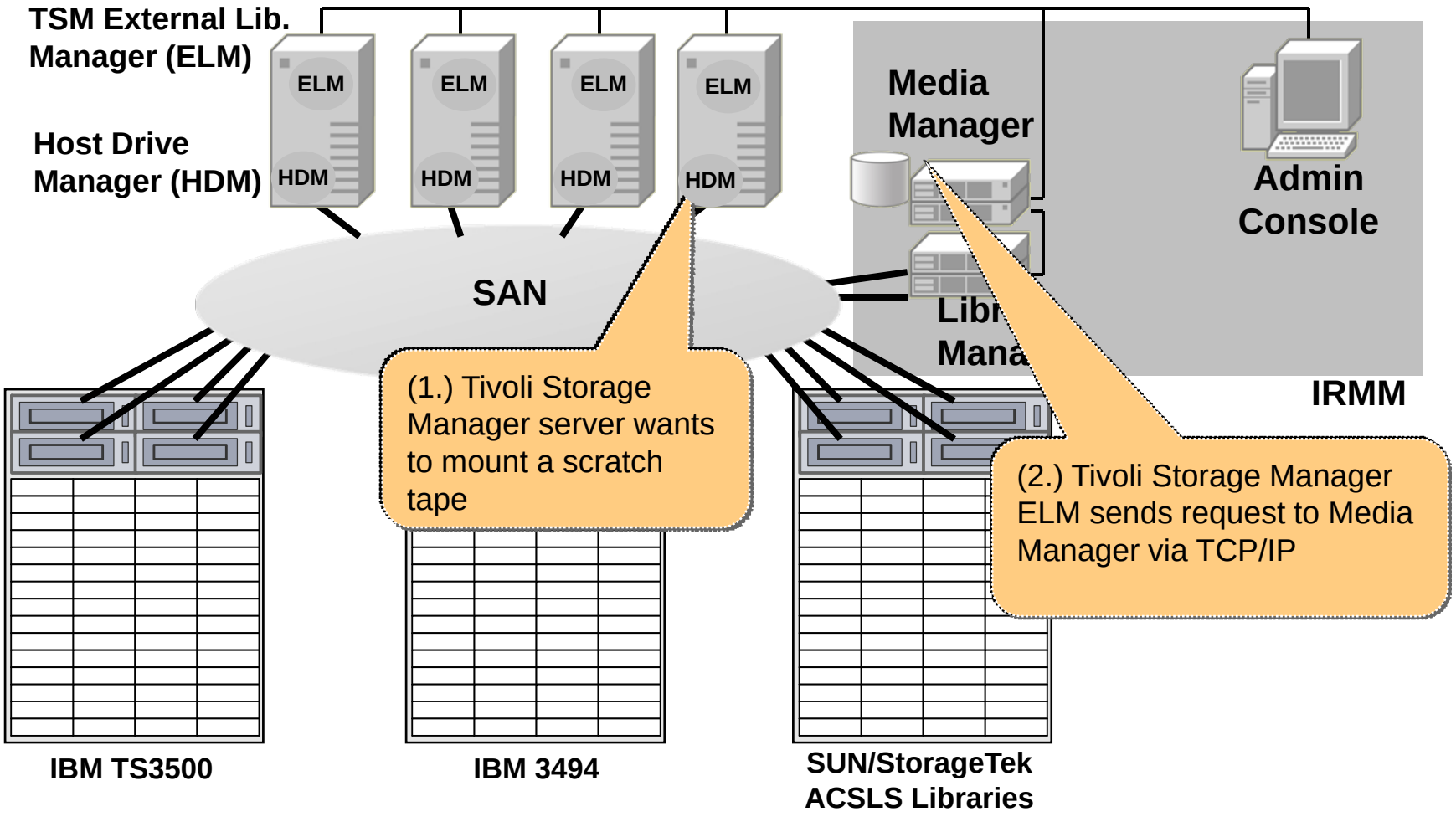
IEEE 1244 compliant: IBM Integrated Removable Media Manager (IRMM)



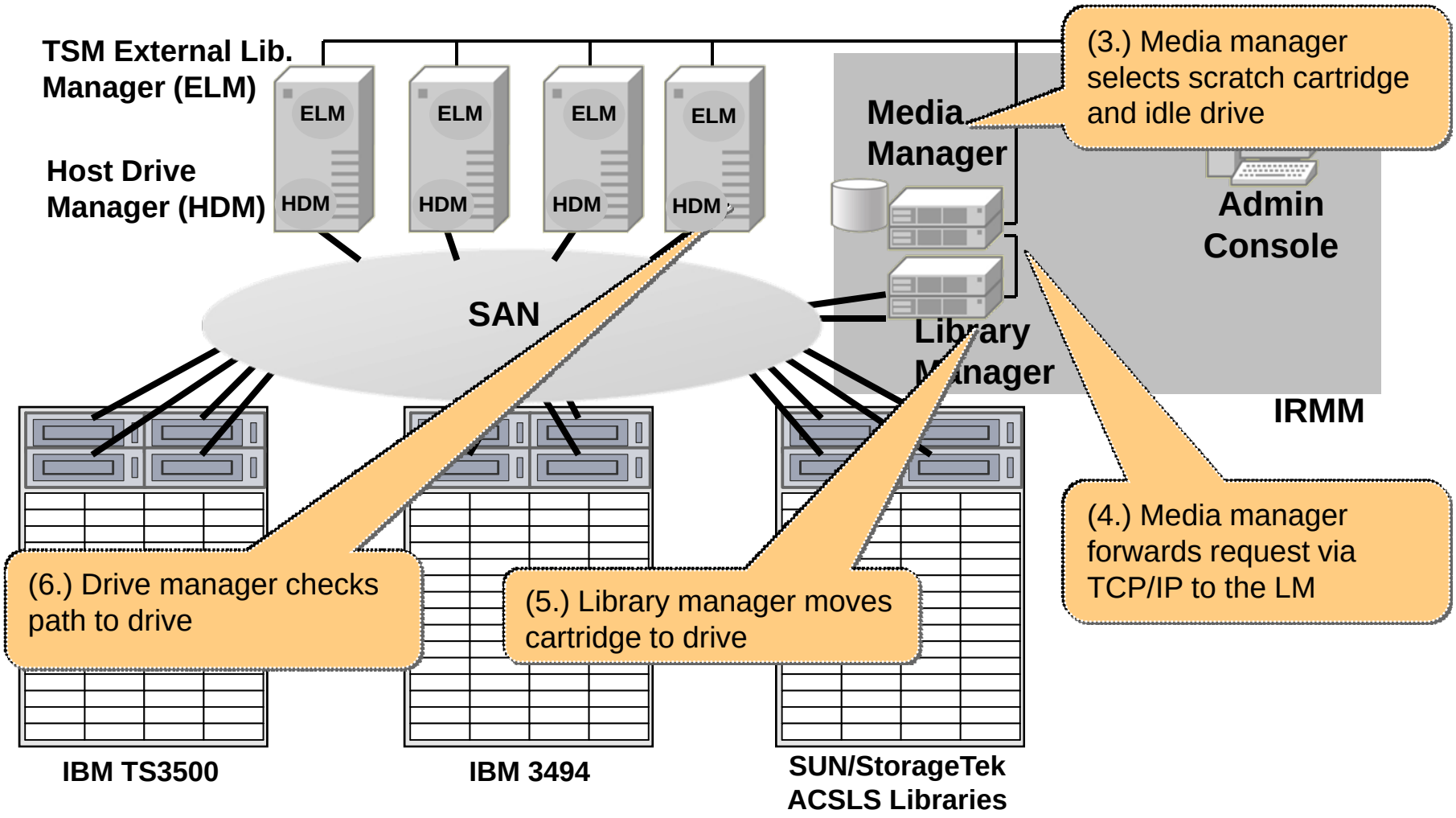
MMS Architecture (cont.)



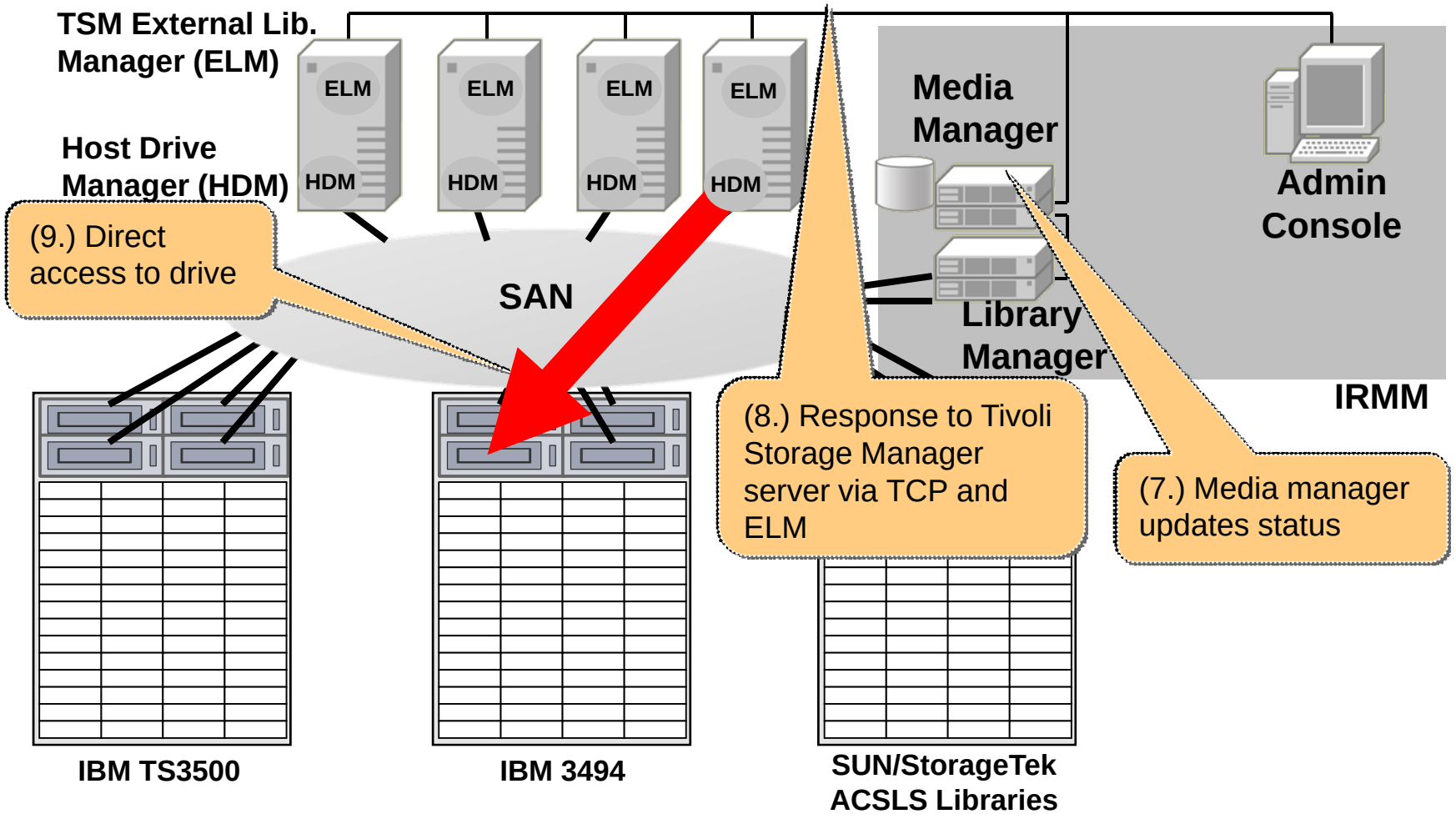
MMS Control Flow



MMS Control Flow (cont.)



MMS Control Flow (cont.)



Tape Virtualization Has Many Faces

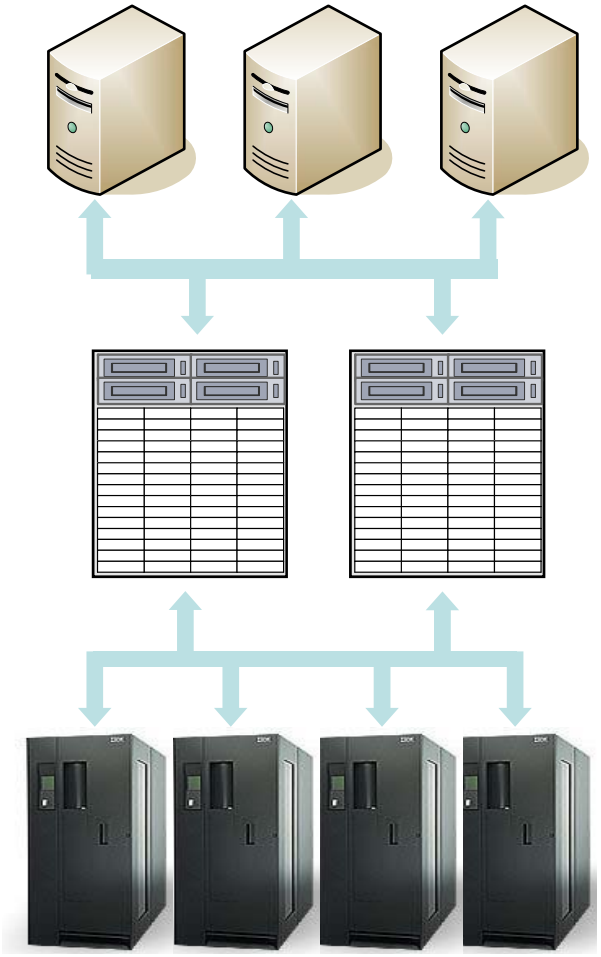
Tape virtualization choices

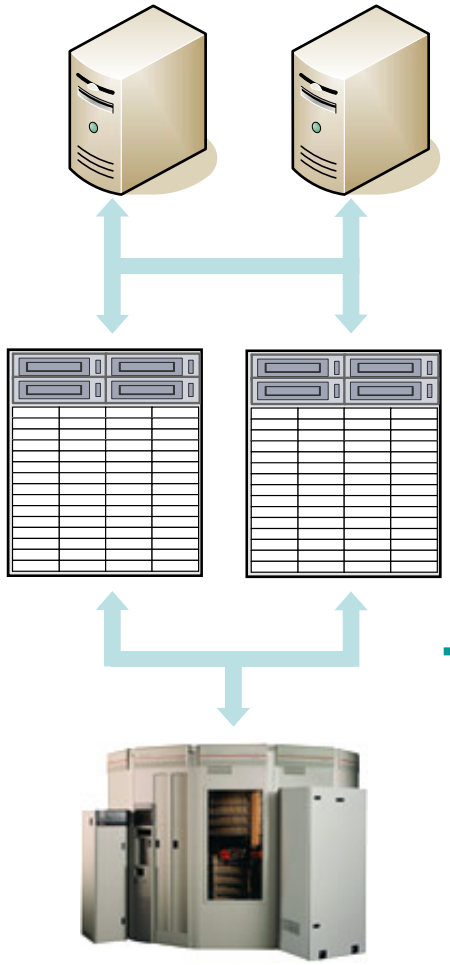
Type	Description	
	What/where?	Chief benefit
Virtual tape	Temporary disk workspace organized data for writing to tape	More-efficient use of tape cartridges
Virtual tape library	Disk storage is used to emulate a physical tape library	Increased reliability of restoration, shortened backup times
Tape library virtualization	Flexibly allocates tape drives and tape slots of a physical tape library	More-efficient use of tape library resources

Source: Mesabi Group

http://www.infostor.com/display_article/253700/23/ARTCL/none/none/1/Tape-virtualization-has-many-faces/

Tape Library Virtualization



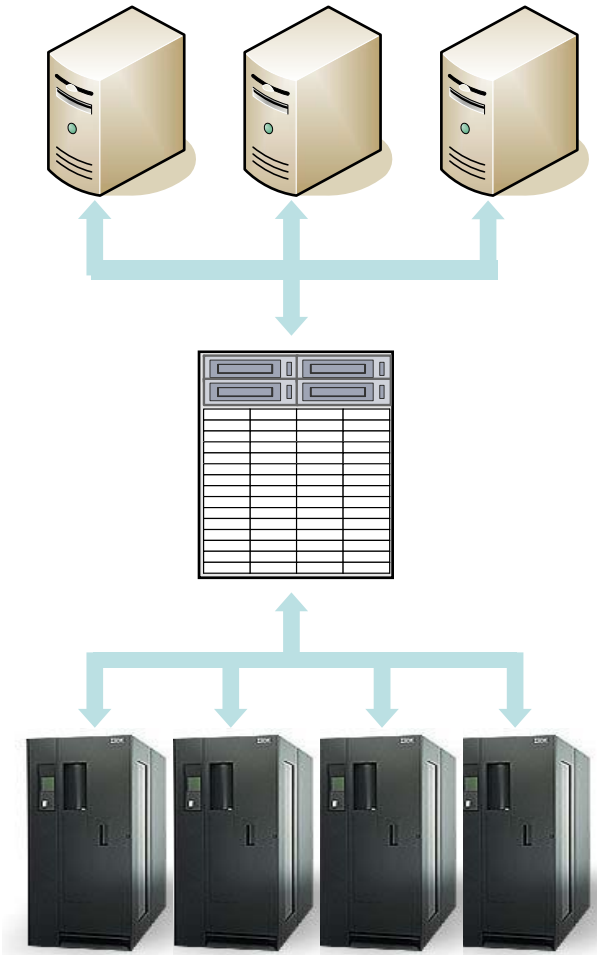


Backup / Archive Applications

Virtual Libraries presented by MMS

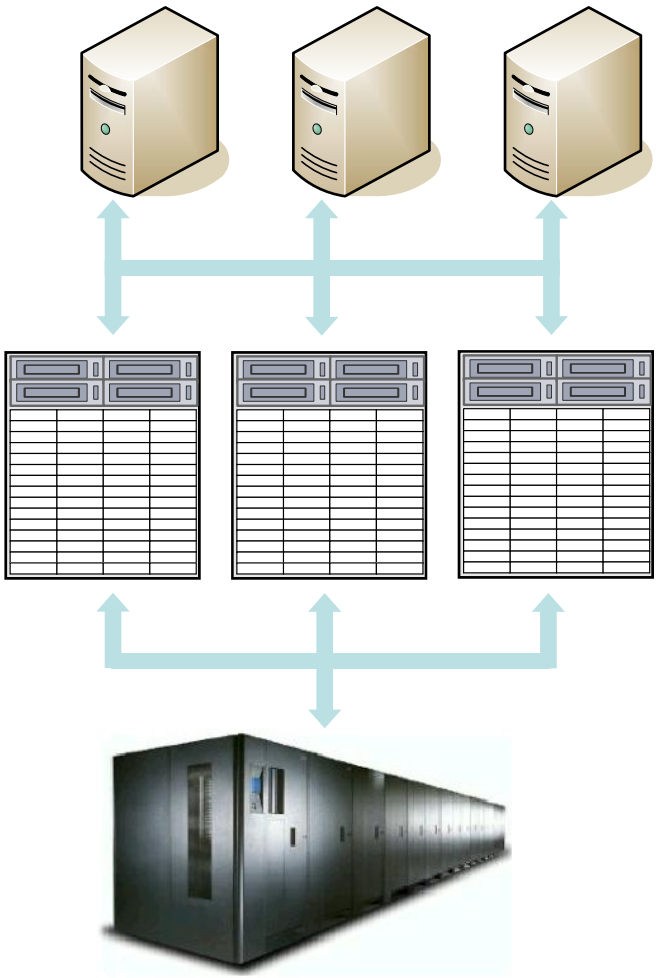
Physical Tape Storage

One Pool of Tape Storage



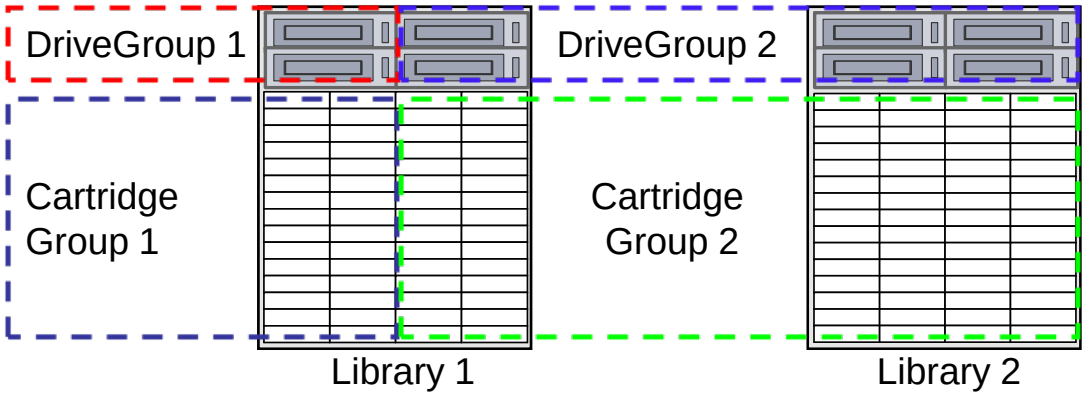
- Logical pool of tape storage beyond physical library boundaries
- Applications only have to deal with one library
- Physical storage capacity can easily be added without changes to the application
- Scratch mounts still possible as long as one physical library is online
- MMS may provide workload balancing by distributing scratch mount requests
- Preferably done with homogeneous physical tape drives / media

Multiple Logical Libraries



- Dynamically configurable logical libraries on top of one physical library
- IRMM prevents unauthorized application access
- Supports heterogeneous environments

Dynamic grouping of drives and cartridges



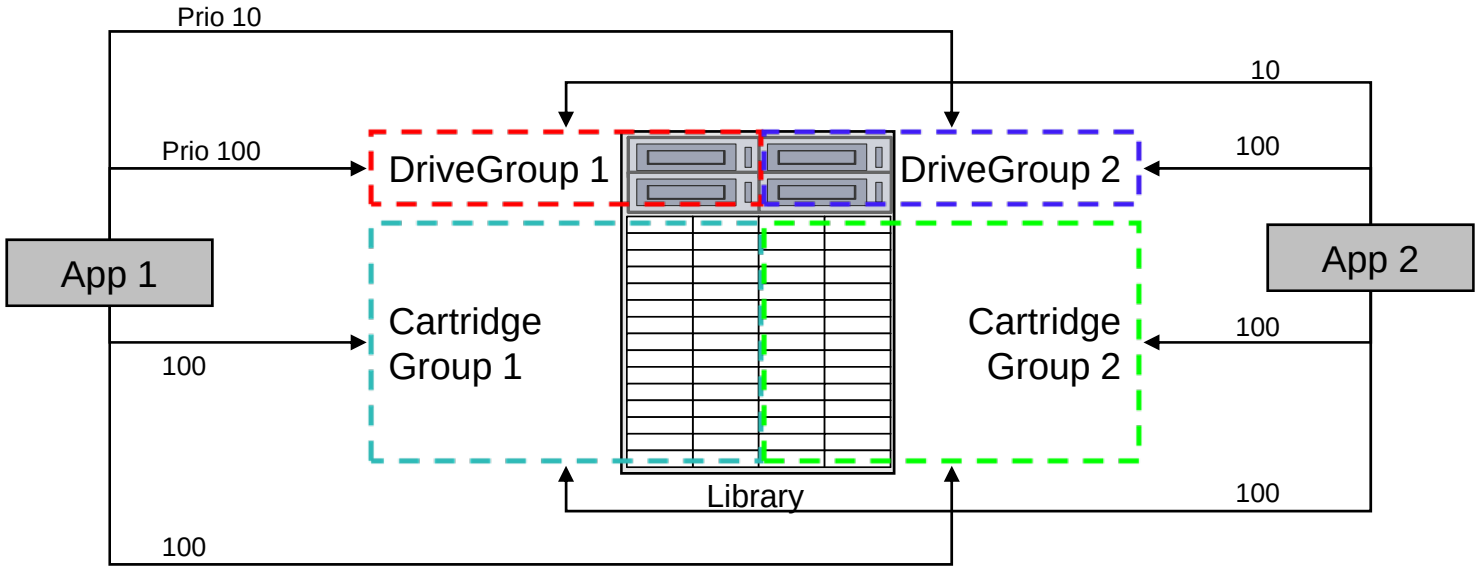
DriveGroups:

- Used to aggregate drives
- Drives can be added and removed dynamically
- Used to implement access permission model and preferential usage policy
- May span multiple libraries

CartridgesGroups:

- Used to aggregate cartridges
- Cartridges can be added and removed dynamically
- Used to implement access permission model and preferential usage policy
- May span multiple libraries

Access Permission Model and Preferential Usage Policy using DriveGroups and CartridgeGroups



Access Permission Model:

- Applications are subject to access control
- Two – level access permission model
- Administrative applications may access every Drive
- Standard applications may only access Drives within DriveGroups which have been assigned to them by an administrative application

Preferential Usage Policy:

- DriveGroup-Application relations have priority attribute
- Drives have priority attribute too
- Priority is used by IRMM to find drive for a mount operation

SMC vs. IEEE 1244

- **SCSI Media Changer (SMC) Interface:**
  - In-band
  - Get slot/drive - element address map
  - MOVE MEDIUM FROM element address TO element address

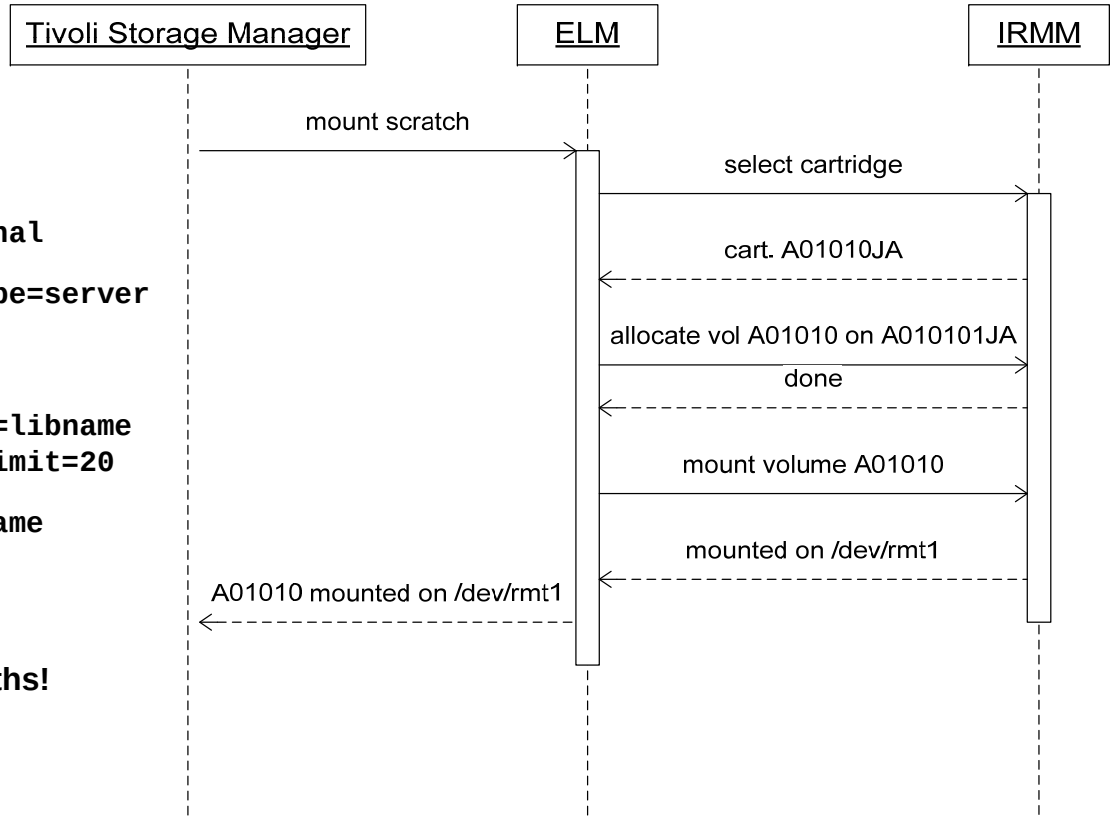
- **IEEE 1244 Interface:**
  - Out-of-band
  - Application awareness
    - Authorization, Ownership, Audit Trails
  - Cartridge state change awareness
    - Scratch ➔ Private
    - Private ➔ Scratch
  - SQL – like queries
  - Rich MM functionality

Application Interface

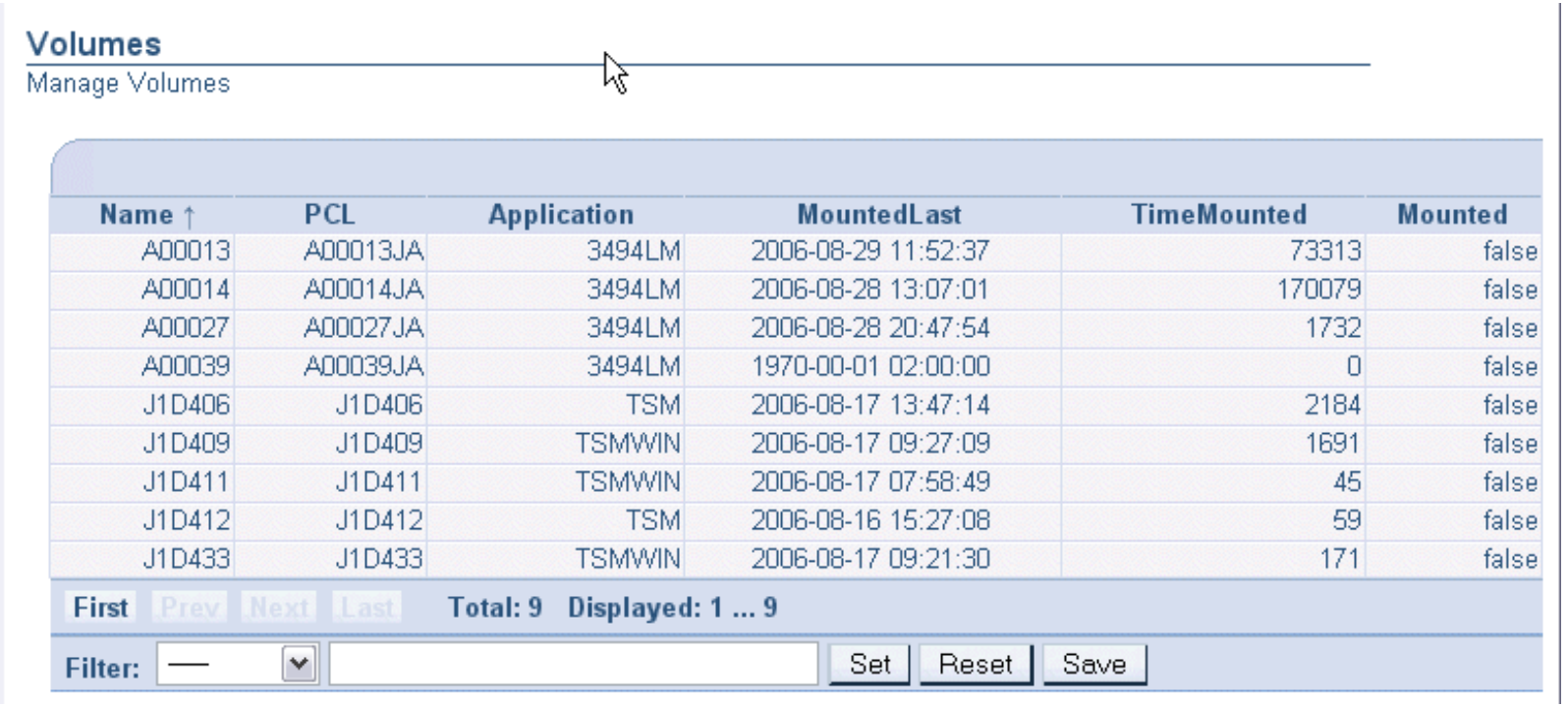
How to define IRMM managed resources:

1. `define library libname libtype=external`
2. `define path servername libname srctype=server desttype=library externalmanager= /opt/IBM/ermm/client/tsm/elm`
3. `define devclass devclassname library=libname devtype=3592 mountretention=5 mountlimit=20`
4. `define stgpool stgpoolname devclassname maxscratch=500`

- **That's all!**
- **You don't have to define drives and drive paths!**



Volumes Allocated on Cartridges



Volumes

Manage Volumes

Name ↑	PCL	Application	MountedLast	TimeMounted	Mounted
A00013	A00013JA	3494LM	2006-08-29 11:52:37	73313	false
A00014	A00014JA	3494LM	2006-08-28 13:07:01	170079	false
A00027	A00027JA	3494LM	2006-08-28 20:47:54	1732	false
A00039	A00039JA	3494LM	1970-00-01 02:00:00	0	false
J1D406	J1D406	TSM	2006-08-17 13:47:14	2184	false
J1D409	J1D409	TSMWIN	2006-08-17 09:27:09	1691	false
J1D411	J1D411	TSMWIN	2006-08-17 07:58:49	45	false
J1D412	J1D412	TSM	2006-08-16 15:27:08	59	false
J1D433	J1D433	TSMWIN	2006-08-17 09:21:30	171	false

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Dynamic Assignment of Cartridges to Groups

Cartridges

Manage Cartridges

0x12c Group

	PCL ↑	Type	Group	Library	State	Mounts
☐	A00004	3592JA	0x12c	3494-1	allocatable	4
☐	A00013JA	3592JA	0x12c	3584-1	allocated	31
☐	A00014JA	3592JA	0x12c	3584-1	allocated	14
☐	A00016JA	3592JA	ScratchPool	3584-1	allocatable	0
☐	A00022JA	3592JA	ScratchPool	3584-1	allocatable	3
☐	A00023JA	3592JA	ScratchPool	3584-1	allocatable	0
☐	A00024JA	3592JA	ScratchPool	3584-1	allocatable	0
☐	A00025JA	3592JA	ScratchPool	3584-1	allocatable	0
☐	A00026JA	3592JA	ScratchPool	3584-1	allocatable	0
☐	A00027JA	3592JA	0x12c	3584-1	allocated	16
☐	A00039JA	3592JA	0x12c	3584-1	allocated	11
☐	J1D405	3592JA	0x12c	3494-1	allocatable	3
☐	J1D406	3592JA	TSM	3494-1	allocated	17
☐	J1D409	3592JA	TSMWIN	3494-1	allocated	14
☐	J1D411	3592JA	TSMWIN	3494-1	allocated	13

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CartridgeGroups are assigned to Applications

CartridgeGroup-Application Objects

Manage CartridgeGroup-Application Objects

Group ↑	Application	Priority
0x12c	3494LM	1000
0x12c	ERMMSystem	1000
0x12d	3494LM	1000
0x12d	ERMMSystem	1000
0xff00	3494LM	1000
0xff00	ERMMSystem	1000
0xff10	3494LM	1000
0xff10	ERMMSystem	1000
Default	ERMMSystem	1000
ScratchPool	3494LM	1000
ScratchPool	ERMMSystem	1000
ScratchPool	TSM	1000
ScratchPool	TSMWIN	1000
TSM	TSM	1000
TSMWIN	TSMWIN	1000

Total: 15 Displayed: 1 ... 15

3494 Emulation on top of MMS

Common Scratch Pool

Private Pool for every Application

DriveGroups are assigned to Applications

DriveGroup-Application Objects

Manage DriveGroup-Application Objects

Group ↑	Application	Priority
3494	3494LM	1000
3494	ERMMSystem	1000
Default	ERMMSystem	1000
Default	TSM	1000
Default	TSMWIN	1000

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Three Applications sharing Drives

DriveCartridgeAccess

Manage DriveCartridgeAccess

Drive	Cartridge	Application	AI	TimeMounted	TimeUnmounted ↓
00077850	J1D425	TSM	TSM-1:1	2006-07-26 15:00:55	2006-07-26 15:03:14
00135980	J1D409	TSM	TSM-1	2006-07-26 15:00:48	2006-07-26 15:02:14
00135980	J1D426	TSMWIN	TSM-1	2006-07-26 14:53:14	2006-07-26 14:57:02
00077850	J1D406	TSMWIN	TSM-1:1	2006-07-26 14:53:50	2006-07-26 14:55:00
00077850	J1D433	TSM	TSM-1	2006-07-26 14:52:24	2006-07-26 14:53:17
00077850	J1D406	TSMWIN	TSM-1	2006-07-21 15:12:42	2006-07-21 15:24:38
00135980	J1D411	TSMWIN	TSM-1:1	2006-07-21 15:21:13	2006-07-21 15:22:36
00135980	J1D409	TSM	TSM-1	2006-07-21 15:08:47	2006-07-21 15:20:42
00135980	J1D412	TSMWIN	TSM-1	2006-07-21 15:04:13	2006-07-21 15:05:02
00135980	J1D406	TSMWIN	TSM-1	2006-07-20 13:40:27	2006-07-20 14:42:07
00135980	J1D406	TSMWIN	TSM-1	2006-07-20 11:07:03	2006-07-20 12:08:46
00077850	J1D426	TSMWIN	TSM-1	2006-07-20 11:02:52	2006-07-20 11:03:39
00135980	J1D409	ERMMSystem	ERMMAdmin:1	2006-07-12 09:09:19	2006-07-12 09:10:16
00077850	J1D412	TSM	TSM-1	2006-07-11 16:32:21	2006-07-11 16:34:02
00135980	J1D411	TSMWIN	TSM-1	2006-07-11 16:29:01	2006-07-11 16:32:37

First Prev Next Last Total: 174 Displayed: 145 ... 159

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Host – Drive Access

Drive Managers

Manage Drive Managers

Name	Drive	Host ↑	Handle	StateSoft	StateHard
/dev/rmt6@127.0.0.1	00077850	127.0.0.1	/dev/rmt6	absent	ready
/dev/rmt5@127.0.0.1	00135980	127.0.0.1	/dev/rmt5	absent	ready
/dev/rmt11@127.0.0.1	3584-1-257	127.0.0.1	/dev/rmt11	absent	ready
/dev/rmt8@127.0.0.1	3584-1-258	127.0.0.1	/dev/rmt8	absent	ready
//./Tape5@9.155.87.80	00077850	9.155.87.80	//./Tape5	absent	ready
//./Tape1@9.155.87.80	00135980	9.155.87.80	//./Tape1	absent	ready
//./Tape0@9.155.87.80	3584-1-257	9.155.87.80	//./Tape0	absent	ready
//./Tape4@9.155.87.80	3584-1-257	9.155.87.80	//./Tape4	absent	ready
//./Tape2@9.155.87.80	3584-1-258	9.155.87.80	//./Tape2	absent	ready
//./Tape3@9.155.87.80	3584-1-258	9.155.87.80	//./Tape3	absent	ready

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Mount History

DriveCartridgeAccess

Manage DriveCartridgeAccess

Drive	Cartridge	Application	AI	TimeMounted	TimeUnmounted ↓
IBM3584-257	496AFQL2	TSM	TSM@ermm	2005-07-03 12:01:19	2005-07-03 12:03:30
IBM3584-257	495AFQL2	TSM	TSM@ermm	2005-07-03 11:52:51	2005-07-03 11:54:00
IBM3584-256	486AFQL2	ERMMSystem	ERMMAdmin:3	2005-06-30 17:35:18	2005-06-30 17:36:24
IBM3584-256	485AFQL2	ERMMSystem	ERMMAdmin:2	2005-06-30 17:20:04	2005-06-30 17:23:15
IBM3584-257	483AFQL2	ERMMSystem	ERMMAdmin:2	2005-06-30 17:19:30	2005-06-30 17:21:09
IBM3584-256	486AFQL2	ERMMSystem	ERMMAdmin:1	2005-06-29 18:56:28	2005-06-30 17:17:51
IBM3584-257	483AFQL2	ERMMSystem	ERMMAdmin:2	2005-05-18 14:06:59	2005-05-18 14:08:12
IBM3584-256	485AFQL2	ERMMSystem	ERMMAdmin:1	2005-05-13 07:51:10	2005-05-13 09:58:51
IBM3584-257	483AFQL2	ERMMSystem	ERMMAdmin:1	2005-05-13 07:48:50	2005-05-13 07:53:47
IBM3584-256	483AFQL2	ERMMSystem	ERMMAdmin:1	2005-05-11 12:49:44	2005-05-11 12:51:53
IBM3584-256	497AFQL2	TSM	TSM@ermm:2	2005-05-11 12:18:29	2005-05-11 12:19:42
IBM3584-257	496AFQL2	TSM	TSM@ermm:1	2005-05-11 12:16:27	2005-05-11 12:19:40
IBM3584-256	495AFQL2	TSM	TSM@ermm	2005-05-11 12:16:26	2005-05-11 12:17:56
IBM3584-257	495AFQL2	TSM	TSM@ermm	2005-05-11 11:41:20	2005-05-11 11:59:44
IBM3584-256	496AFQL2	TSM	TSM@ermm	2005-05-11 11:53:52	2005-05-11 11:58:12

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SMI-S and IEEE 1244

Storage Media Library (SML) Profile:

- Clause 4: Storage Library Profile
- Clause 5: Element Counting Subprofile
- Clause 6: InterLibraryPort Connection Subprofile
- Clause 7: Library Capacity Subprofile
- Clause 8: LibraryAlert Events/Indications for Library Devices
- Clause 9: Limited Access Port Elements Subprofile
- Clause 10: Media Movement Subprofile
- Clause 11: Virtual Tape Library System Profile
- Clause 12: Virtual Tape Library Copy Profile

CIM-Mapping for IEEE 1244:

Title: CIM Mapping of the IEEE SSSWG Media Manager Model		
Date: 02/24/2000		
Author: Andrea Westerinen		
IEEE Object	Attribute Name	CIM Property
This spreadsheet reflects the class and association hierarchy defined by the CIM Schema V2.2.		

IEEE 1244 gaining more traction?

OpenSolaris Project: Media Management System

View the leaders for this project
Project Observers

Endorsing communities

Storage

Welcome to MMS

The Media Management System (MMS) is a new magnetic tape and tape library managment facility based on IEEE standard 1244, Media Management System. The primary function of MMS is to provide a removable media mounting surface in a distributed environment.

http://www.opensolaris.org/os/project/mms/

Links & References

- IEEE Storage Systems Standards Working Group
- IBM Integrated Removable Media Manager
- Media Management System for OpenSolaris
- SGI OpenVault
- Troppens, Erkens, Mueller: Storage Networks Explained