SHARE

Technology · Connections · Results

Session
5519
Linux and IBM Storage
9226

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Agenda

- Linux Overview

- eServer Platforms

- Storage Connectivity Options

- IBM Storage Offerings

  - ► Disk Storage

  - ► Tape Storage

- Storage Management

- Resources

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Open e-business platform

Presentation/Access
Portable & Interchangeable

Data/Documents
Portable & Interchangeable

Web

XML

Business Logic
Portable & Interchangeable

Java

Linux

Development & Operating Environment
Open & Portable
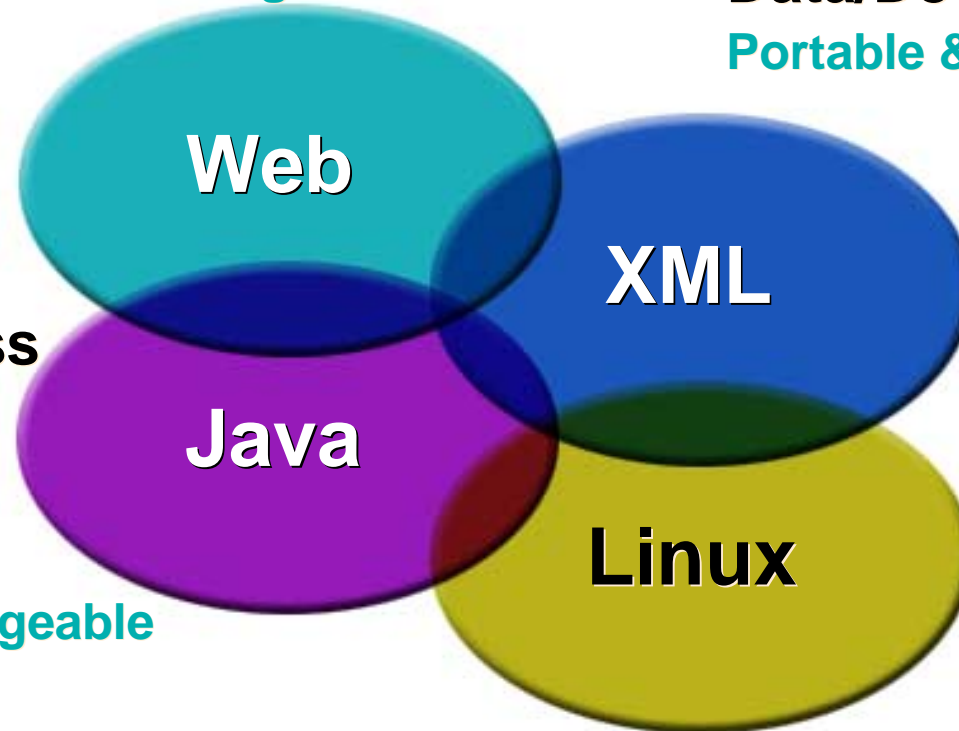
An Integrated Standards and Open Source Model

Linux Momentum Building

2000 New Server OS Shipments

Linux
27.0%

Windows NT®
40.9%

NetWare
16.8%

Combined
UNIX
13.5%

1.9%
Other NOS
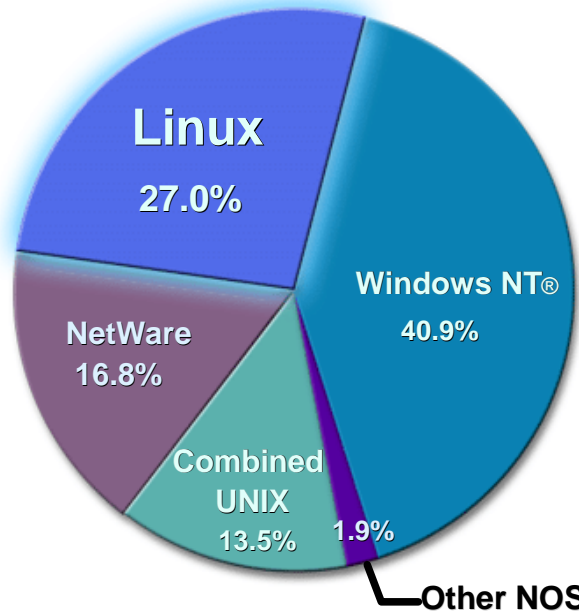
- 1999 - 2000 Linux shipments grew 24% YTY
- 2000: #2 volume OS
- Linux shipments projected to have highest growth (99 - 05)

Source: IDC, 2001

New Server OS License Forecast (00 - 05)

Other
Combined UNIX®
Novell® NetWare

Linux
23.6% Growth

Windows NT
16.5% Growth

2000 2001 2002 2003 2004 2005

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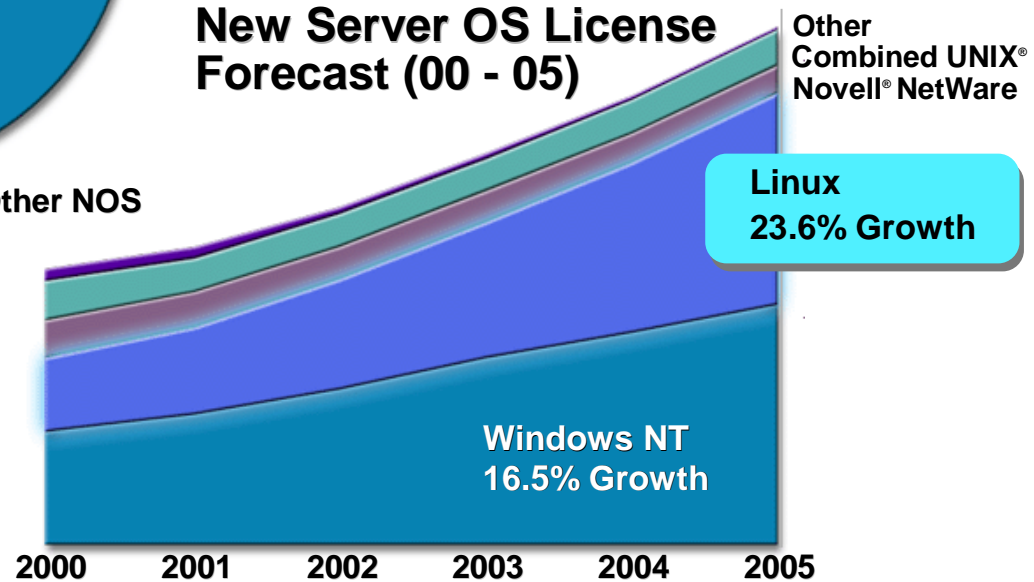
Linux Terminology explained

Applications

Thousands of applications have been ported to Linux

Middleware

WebSphere
DB2
Lotus Domino, Tivoli
MQ Series
Java Runtime Environment (JRE)

Distribution Tools and Utilities

Red Hat
SuSE
TurboLinux
Caldera
... others

Kernel Level

Kernel 2.2.x
Kernel 2.4.x

Instruction Set

Intel Architecture IA-32, IA-64
PowerPC (Power3, Power4)
S/390 (aka zSeries)

(c) IBM Corp. 2001, 2002.

IBM eServer xSeries

Linux available for xSeries:

✓ *IBM Netfinity servers*
- Rack-optimized - More computing power per square foot
- X-architecture brings enterprise-class scalability, reliability & security to Intel-based servers
- Certified under the IBM ServerProven Program

  for *Caldera, Red Hat, SuSE and TurboLinux*
- Preloads for Caldera, Red Hat and TurboLinux

✓ *IBM Thinkpads*
- All 4 distributions supported

✓ *IBM Intellistations*
- All 4 distributions supported

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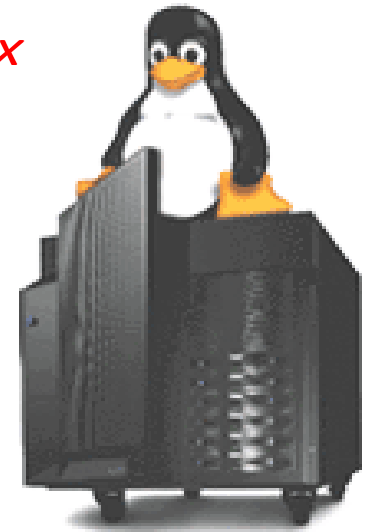
Linux on eServer iSeries

The Point of Coexistence - Where Linux Complements Integrated e-business Solutions

LPAR1 OS/400 V5R1	LPAR2 OS/400 V4R5	LPAR3 Linux	LPAR 4 Linux	LPAR... Linux

Primary Partition
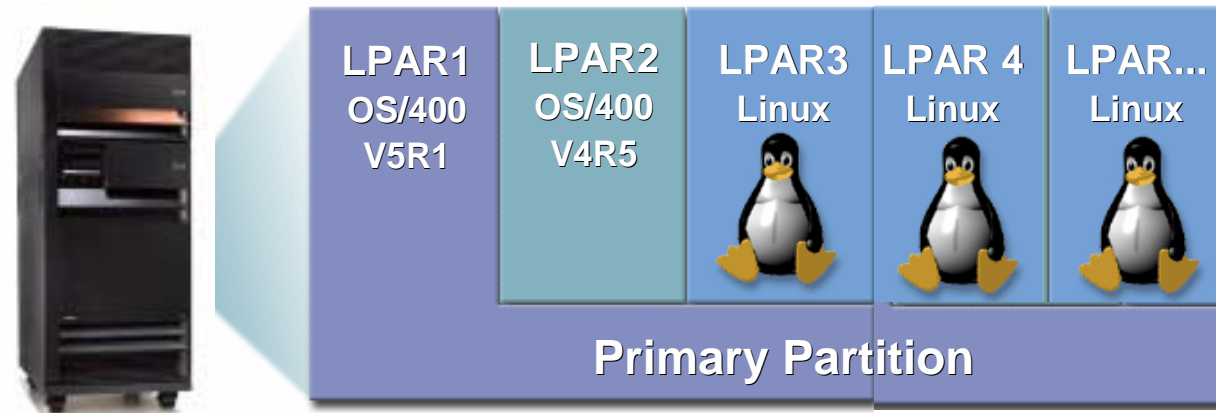
iSeries support of Linux provides:

- Linux runs in iSeries logical partition up to 31 Linux servers on one iSeries
- Flexible allocation of process, memory and I/O resources to applications
- iSeries scalability, availability and ease-of-use for Linux applications

IBM eServer pSeries

Linux available for pSeries:

- ✓ *IBM RS/6000 and pSeries servers*
  - Industry-leading clustering
  - Rugged, high-density, rack-mounted systems
  - RS/6000 43P-150, B50 "Pizzazz", F50
  - pSeries 640, 680 and 690 "Regatta"
- ✓ **Linux for PowerPC Distributions**
  - SuSE
  - Red Hat
  - TurboLinux (under development)
- ✓ **AIX Affinity for Linux Strategy**
  - AIX Toolbox for Linux for AIX 4.3.3 and 5L
  - "Linux GNU" tools, utilities, RPM for AIX
  - Integrated Linux APIs into AIX lib.c
- ✓ **Partitioning Support**
  - pSeries 690 allows up to 16 partitions

RPM = Red Hat Package
Manager
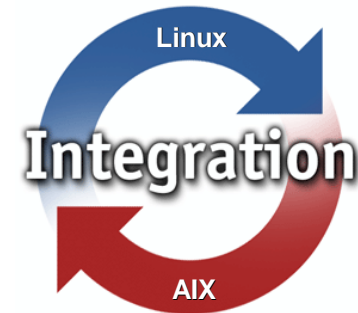
IBM eServer zSeries
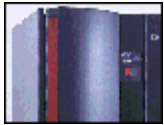
Linux available today for:

✓ *S/390 and zSeries family*
- World's most scalable server
- z800 and z900 models supported
- Bullet-proof reliability
- Dynamic workload management
- DB2, WebSphere, MQSeries, Java, Tivoli

✓ *Linux Distributions*
- Linux <u>for</u> S/390 for 32-bit architecture
- Linux <u>for</u> zSeries for 64-bit architecture } Linux <u>on</u> S/390
- Linux distributions from: SuSE, TurboLinux, Red Hat

✓ *Variety of Operational Modes*
- Native
- Logical Partition (LPAR)
  - Integrated Facility for Linux (IFL)
- Guests under VM, z/VM
  - z/VM 4.2 can run on IFL engines

Introducing **LINUX** for **S/390**
S/390 reliability, Linux flexibility

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Storage Connectivity Options

- **Positioning**
  - ► Storage Area Network (SAN)
  - ► Block-oriented protocol (iSCSI)
  - ► File-oriented protocols (NAS)

- **Storage Protocol comparison**

- **Connectivity Options**

SAN, iSCSI and NAS positioning

SAN	iSCSI	NAS
▪ Block I/O optimization ▪ High Performance & Scalability ▪ Fibre Channel protocols ▪ Longer design and installation time ▪ Typically more expensive ▪ Requires significant IT support	▪ Block I/O optimization ▪ Better Performance & Scalability than file-based solutions ▪ Ethernet connections - TCP/IP protocols ▪ Self-contained and quick to install ▪ Less expensive than SAN storage	▪ File I/O optimization ▪ Performance & Scalability Considerations ▪ Requires little IT support ▪ Ethernet connections - TCP/IP protocols ▪ Self-contained and quick to install ▪ Typically less expensive

IP Network

Servers

SAN

Storage

IP Network

iSCSI

IP Network

NAS

"Storage Grid" ———— "File Grid"

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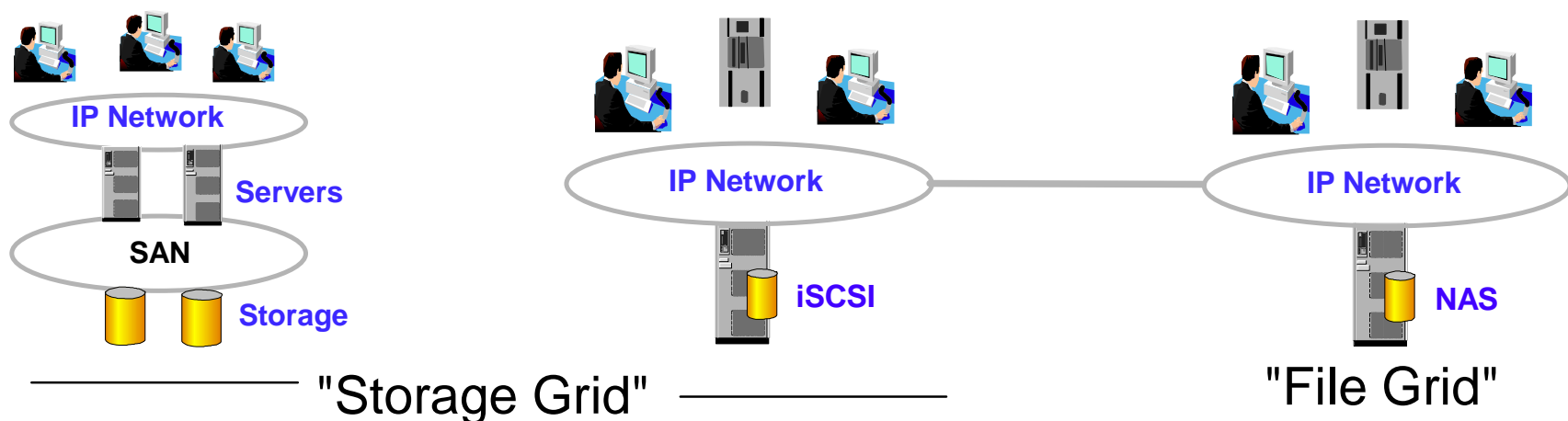
Storage Protocols

- Small Computer System Interface (SCSI)
  - ► Industry standard parallel interface
  - ► Ultra, Ultra 2, Ultra 3, and SPI-4
- Serial Storage Architecture (SSA)
  - ► Industry standard serial interface
- Fibre Channel Protocol (FCP) SCSI over Fibre Channel
  - ► Point-to-Point
  - ► Arbitrated Loop
  - ► Switched Fabric
- Enterprise Storage Connection (ESCON)
  - ► Enhanced Count-Key-Data (ECKD) for S/390, zSeries
- Fibre Connection (FICON)
  - ► ESCON protocol over Fibre Channel

Storage Network Connectivity

Server   Protocol   Subsystem

SCSI Adapter

SAN Data Gateway for Serial Disk

SSA Port

SCSI

SCSI Port

xSeries
pSeries
iSeries

SAN Data Gateway

SCSI

FCP Adapter

FCP

Native FC Port

FC Switch

ESCON Adapter

ESCON Director

ESCON

ESCON Port

FICON Adapter

FICON Bridge

FICON

FICON Director

FICON Port

zSeries

IP Network Connectivity

IP Network

Data Client

Data Server

NAS

- **Network File System (NFS)**
  - **Clients available on most platforms, including Linux**

- **Common Internet File System (CIFS)**
  - **Formerly known as: Server Message Block (SMB)**
  - **Windows NT / 2000**
  - **Samba Client for Linux**

- **Hipertext Transfer Protocol (HTTP) including FTP**

Data

- **NFS Server**
  - **Linux NFS server**
  - **Variety of other platforms**

- **CIFS Server**
  - **Windows NT / 2000**
  - **Samba Server for Linux**

- **HTTP File Server**

iSCSI

- **iSCSI client (iClient) driver**

- **iSCSI storage subsystem or gateway to SAN devices**

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IBM Storage Offerings

- **Questions for customers to ask a storage vendor**

- **IBM Disk Storage**
  - ► Expandable Storage Plus
  - ► Fibre Array Storage Technology (FAStT)
  - ► Enterprise Storage Server (ESS)
  - ► IBM IP Storage 200i

- **IBM Tape Storage**
  - ► Linear Tape-Open (LTO) Ultrium Drives and Libraries
  - ► Magstar Tape Drives and Libraries

Questions to Ask a Storage Vendor

- What host attachment ports are available on your storage subsystem?
  - ► SCSI, FC-AL, Native (switched) FC, ESCON/FICON
- Which host bus adapters have you tested with?
  - ► There are a variety for each platform
- Which distributions of Linux have these drivers been tested with?
  - ► TurboLinux, SuSE, Red Hat, Caldera, etc.
- Which levels of Linux kernels are supported by these drivers?
  - ► Newer 2.4.x level has better Error Recovery Process (ERP) than the 2.2.x level
- Will your device work with my existing server, adapter, driver, distribution and kernel level?
  - ► This information will help evaluate devices

2104 Expandable Storage Plus (EXP Plus)

Host Attachments available:
- ✓ SCSI-2, Ultra2 SCSI, and Ultra3 SCSI

Powerful Features:
- ✓ Rack-mounted drawer or Tower
- ✓ Multiple RAID levels supported when used v
    with Ultra3 SCSI RAID attachments
- ✓ Scalability:
    Up to 509GB per tower or drawer
- ✓ Redundant, Hot-swappable components

Supported Platforms:
- ✓ AIX 4.2.1 and above
- ✓ Linux applications through AIX 5L

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Fibre Array Storage Technology (FAStT)

Host Attachments available:

- ✓ Fibre Channel
   Point-to-Point, Arbitrated Loop (FC-AL)
   Switched Fabric

Powerful Features:

- ✓ Rack-mounted
- ✓ Multiple RAID levels supported
- ✓ Scalability / FC Support
   FAStT200: 36GB to 4.3TB / 1 Gb
   FAStT500: 36GB to 16TB / 1 Gb
   FAStT700: 36GB to 16TB / 2 Gb
- ✓ Redundant, Hot-swappable components

Supported Platforms:

- ✓ FAStT Storage Manager v7.1 and 8.0 on Linux-Intel Red
   Hat 7.1
- ✓ Windows, HP-UX, Sun Solaris, NetWare, Linux-Intel Red
   Hat 7.1 (2.4.x kernel)
- ✓ FAStT500 also supports AIX
- ✓ Clustering for MC/Service Guard, Veritas, and MSCS

FAStT200
FAStT EXP 500

FAStT500
FAStT700

Enterprise Storage Server (ESS)

Host Attachments available:

- ✓ UltraSCSI
- ✓ FC-AL and Switched Fibre Channel
- ✓ ESCON and FICON

Powerful Features:

- ✓ JBOD and RAID5 levels supported
- ✓ Subsystem Device Driver (SDD)
- ✓ Peer-to-Peer Remote Copy (PPRC)
- ✓ FlashCopy
- ✓ Scalable from 420GB to 22TB useable capacity
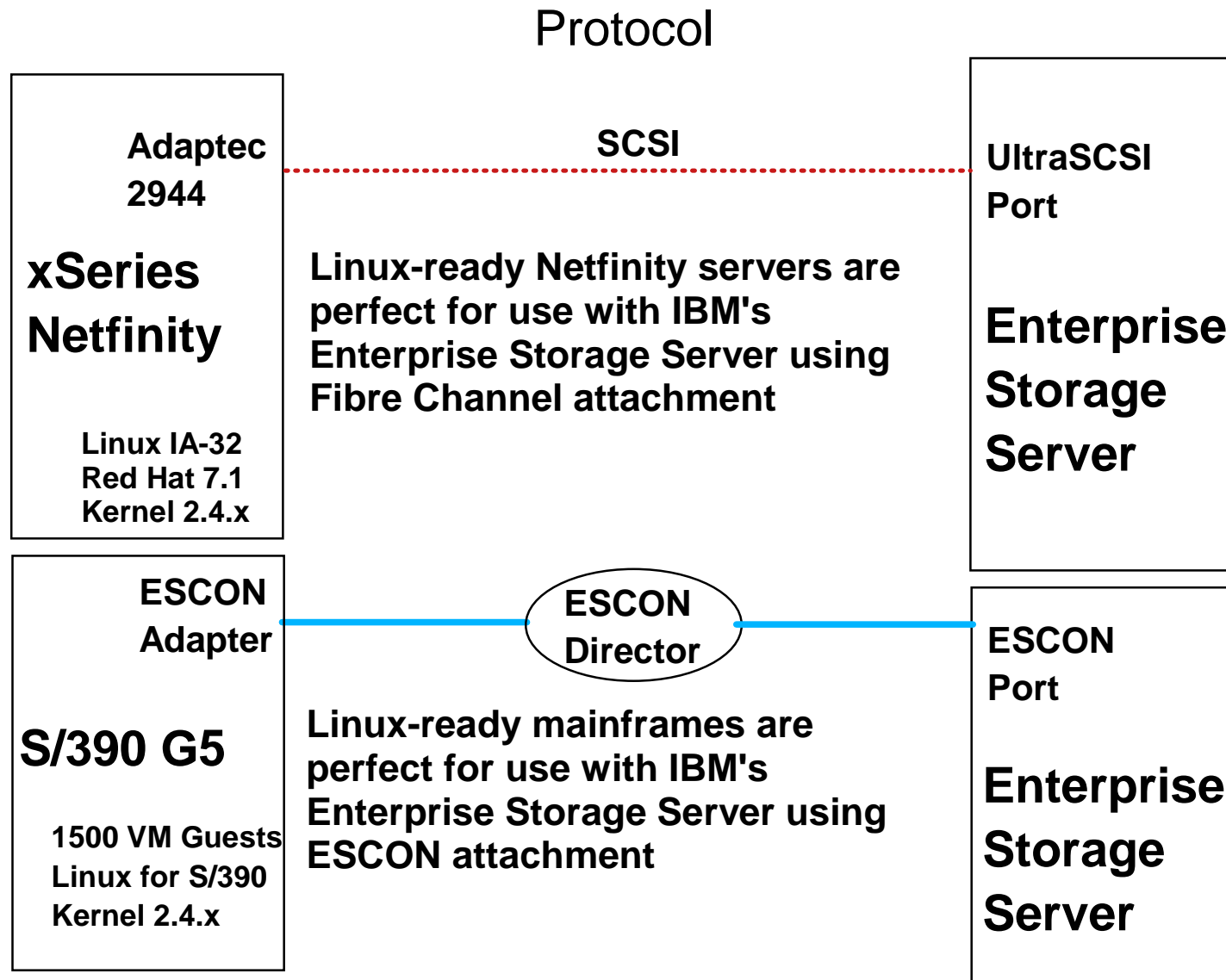- ✓ Full fault tolerance and redundancy

Command Line Interface:

- ✓ Requires Java 1.1.8
- ✓ Available for AIX, Windows, Sun Solaris, HP-UX, and Linux!

Linux Support:

- ✓ zSeries: SuSE, TurboLinux, Red Hat (2.4.x kernel), ESCON
- ✓ xSeries: Linux-Intel Red Hat 7.1, SuSe 7.2, FC on F10/F20 models
- ✓ xSeries: E10/E20 models or SCSI attachment - RPQ

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Example Configurations

Protocol

Adaptec 2944	SCSI - - - - - - - - - - - - - - - - - -	**UltraSCSI Port**
xSeries Netfinity	**Linux-ready Netfinity servers are perfect for use with IBM's Enterprise Storage Server using Fibre Channel attachment**	**Enterprise Storage Server**
Linux IA-32 Red Hat 7.1 Kernel 2.4.x		
ESCON Adapter	ESCON Director	**ESCON Port**
S/390 G5	**Linux-ready mainframes are perfect for use with IBM's Enterprise Storage Server using ESCON attachment**	**Enterprise Storage Server**
1500 VM Guests Linux for S/390 Kernel 2.4.x		

iSCSI - Block-oriented protocol

New standard jointly developed between IBM and Cisco

- IBM IP Storage 200i
  - ► Scalable pooled storage appliance: 108GB - 3.5TB
  - ► High availability redundancies
  - ► Optimized for block I/O database access
  - ► Easy integration into existing network
  - ► Supports Windows NT/2000
  - ► Supports Red Hat 6.2 Linux (2.2.x)
  - ► Linux on S/390 being tested

IP Storage 200i

- Cisco SN 5420 Storage Router
  - ► Extend SAN to IP infrastructure
  - ► Designed for block I/O
  - ► Use existing IP network skills
  - ► Supports Windows NT, Sun, Linux (2.2.x)

Cisco SN 5420 Storage Router

Linear Tape-Open - Ultrium

New standard in tape jointly developed between IBM, Hewlett-Packard and Seagate

Ultrium Tape Drive 3580:
- 100 GB native capacity cartridge
- 15 MB/sec native data rate
- Connectivity: UltraSCSI and FC

Ultrium Tape Autoloader 3581:
- Seven cartridge autoloader (700GB native capacity)
- Connectivity: UltraSCSI and FC

Ultrium Scalable Tape Library 3583:
- 1-6 drives, 18-72 cartridges
- 7.2 TB native capacity
- FC connectivity via internal SAN Data Gateway module

UltraScalable Tape Library 3584:
- 1-72 drives, up to 2,481 cartridges
- 248 TB native capacity
- DLT frame option, 1-12 drives, up to 360 cartridges
- Native FC LTO drives

3580 Tape Drive

3581 Tape Autoloader

Scalable Tape Library

UltraScalable Tape Library

Linux-Intel support
✔ Red Hat 7.1
(kernel 2.4.x)

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Magstar Tape Drive

3590 B11/B1A tape drive

- 10 or 20 GB native capacity cartridge
- 9 MB/sec native data rate
- Connectivity
  - ✓ **Ultra SCSI with dual data ports**
  - ✓ **FCP via San Data Gateway**
  - ✓ **ESCON**

3590 E11/E1A tape drives

- 20 or 40 GB native capacity cartridge
- 14 MB/sec native data rate
- Investment Protection
  - ✓ **Field upgradable from B1X Models**
  - ✓ **Media Reuse**
- Connectivity
  - ✓ **Ultra SCSI with dual data ports**
  - ✓ **FCP via San Data Gateway to SCSI drives**
  - ✓ **Native Fibre Channel**
  - ✓ **ESCON**

3494 Tape Library

3590 Rack-Mount

Linux-Intel support Red Hat 7.1 (kernel 2.4.x) for Ultra SCSI

LinuxPPC for iSeries LPAR Red Hat 7.1 SCSI or ESCON

Linux on S/390 support ESCON emulating 3490E

Storage Management

- Storage Management can provide backup, archive and space management facilities for your data

- Linux on S/390

    - Compatible Disk Layout (CDL)

- Tivoli Storage Manager

    ► Client and Server platforms supported

    ► Client Requirements for Linux IA-32

    ► Network Storage Manager

- Tivoli SANergy

Linux on S/390 Compatible Disk Layout

dasdfmt utility

Track 0
Volume
Label
Track 1
Volume
Table
of Contents
(VTOC)
Remaining Tracks
fixed block size
(512, 1024, 2048 or
4096)
4096 is most efficient
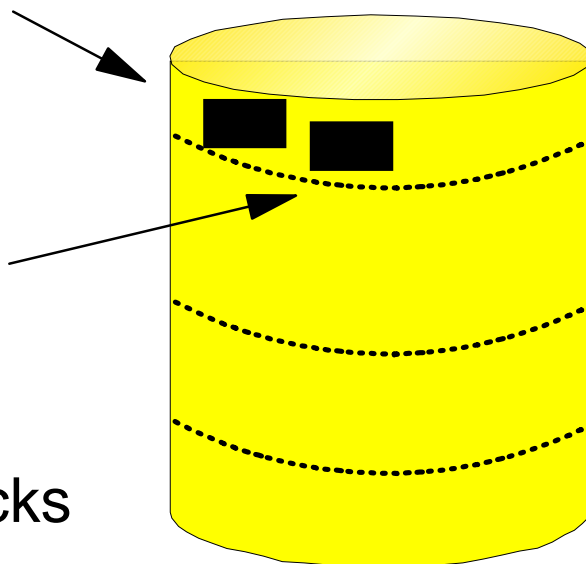
fdasd utility

Tracks 2-n
can be carved
up into 1-3
native or swap
partitions

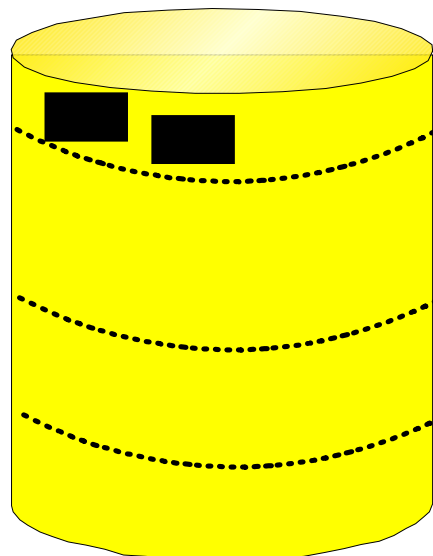Each partition
described in
VTOC as data
set

Kernel 2.4.5

(c) IBM Corp. 2001, 2002.

Linux on S/390 Compatible Disk Layout

Linux view:

/dev/dasd/019b/part1
mounted as /programs

/dev/dasd/019b/part2
mounted as /data

/dev/dasd/019b/part3
mounted as swap space

device=019B
volser=APP037
unit=3390
blocksize=4096
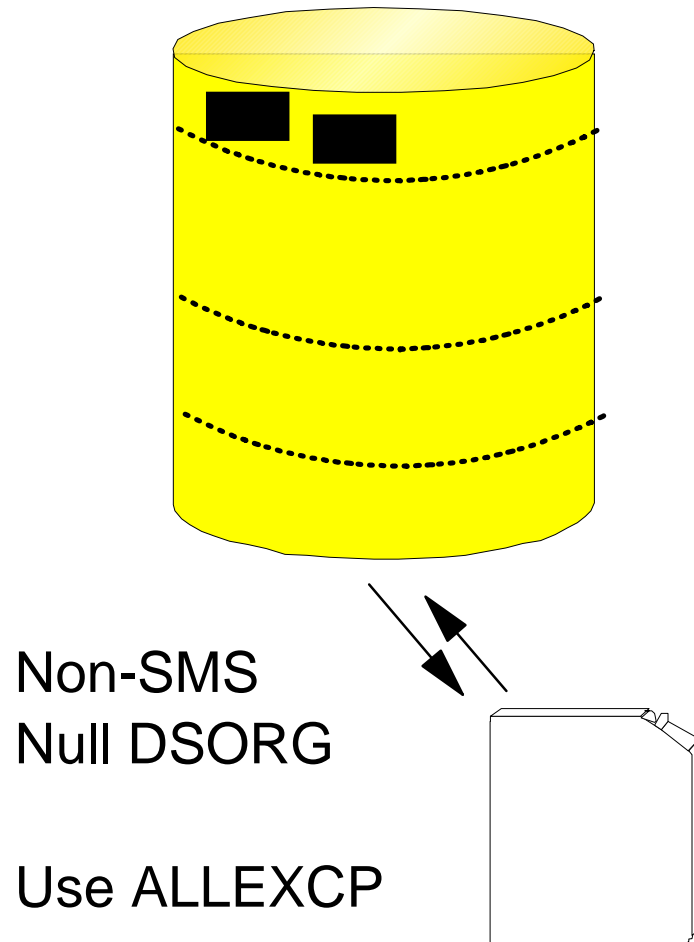
z/OS view:

Label: VOL1VOL1APP037
VTOC: 12 DSCB's

LINUX.VAPP037.PART0001.NATIVE

LINUX.VAPP037.PART0002.NATIVE

LINUX.VAPP037.PART0003.SWAP

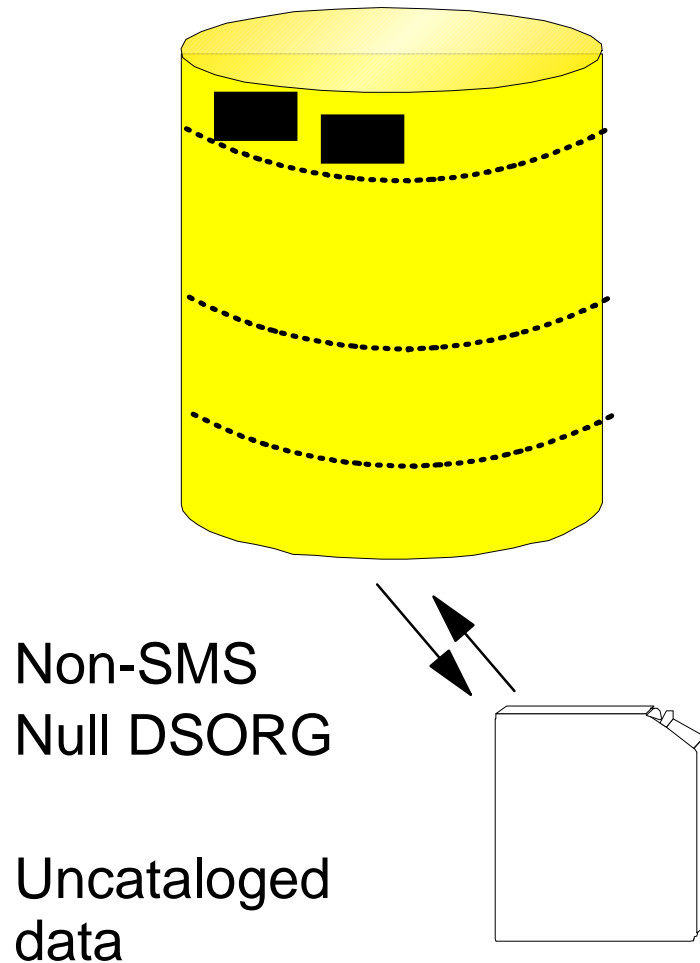Kernel 2.4.5

Linux on S/390 Compatible Disk Layout

Linux volumes can be varied
online to OS/390 and z/OS

DFSMSdss Support
- COPY FULL
- DUMP
  - FULL
  - physical DATASET
- RESTORE
  - FULL
  - physical DATASET
- PRINT
- COPYDUMP

Kernel 2.4.5

Non-SMS
Null DSORG

Use ALLEXCP

(c) IBM Corp. 2001, 2002.

Linux on S/390 Compatible Disk Layout
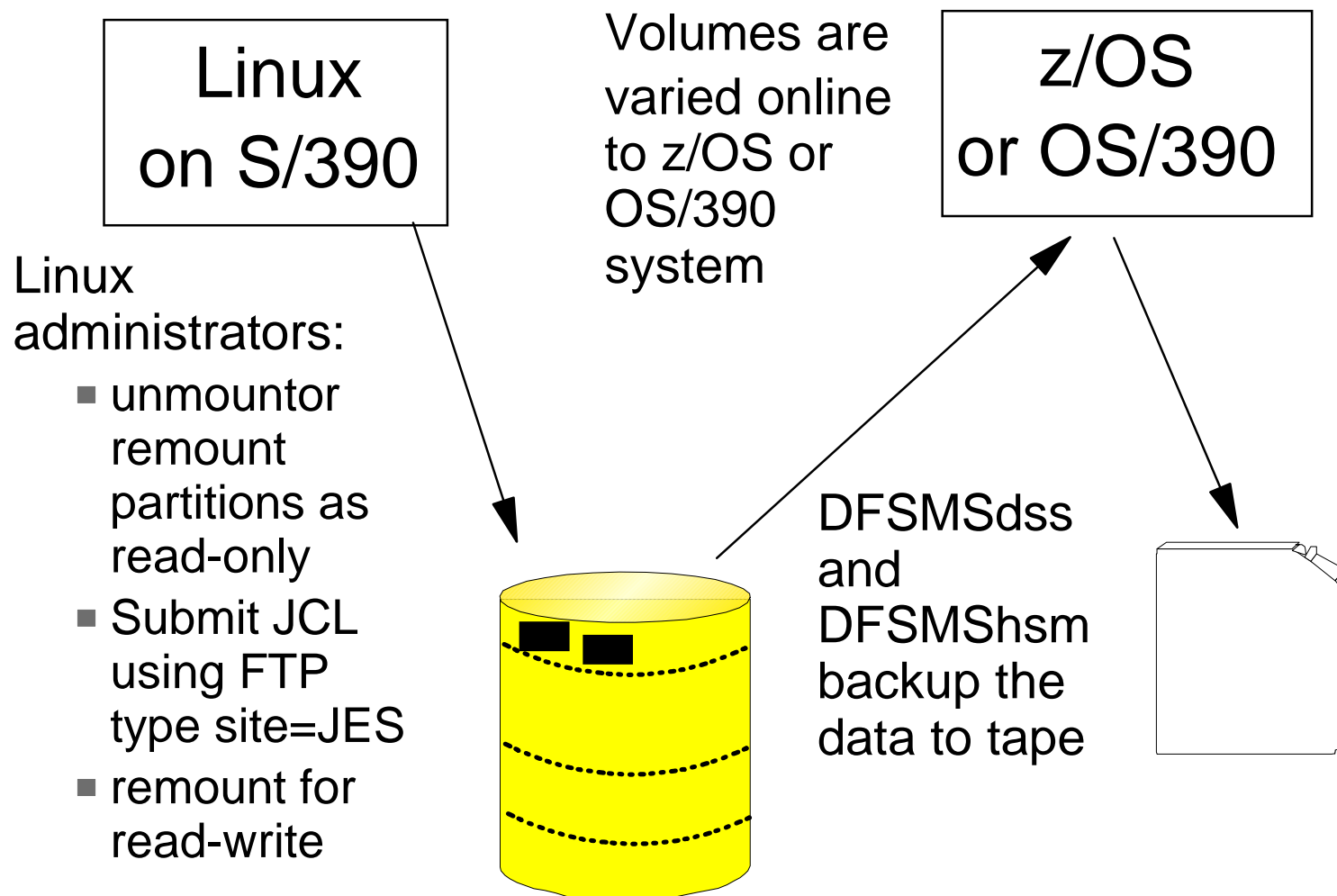

Linux volumes can be varied
online to OS/390 and z/OS

DFSMShsm Support
- ADDVOL PRIMARY
    NOAUTORECALL
    NOAUTOBACKUP
    NOAUTOMIGRATE
- Automatic DUMP
- BACKVOL DUMP
- RECOVER FROMDUMP

Non-SMS
Null DSORG

Uncataloged
data

Kernel 2.4.5

Linux on S/390 Compatible Disk Layout

Linux
on S/390

Volumes are
varied online
to z/OS or
OS/390
system

z/OS
or OS/390

Linux
administrators:

- unmountor
  remount
  partitions as
  read-only
- Submit JCL
  using FTP
  type site=JES
- remount for
  read-write

DFSMSdss
and
DFSMShsm
backup the
data to tape

Kernel 2.4.5

Tivoli Storage Manager (TSM)

IP Network

TSM Backup/Archive Linux Client

Data

- **Linux for IA-32**
- **Linux for S/390**
- **Linux for zSeries**

TSM Server

TSM Storage Pools

TSM DB

TSM Backup Tapes

- **AIX**
- **OS/390, z/OS**
- **z/VM**
- **Windows NT**
- **HP-UX**
- **Sun Solaris**
- **... and others**

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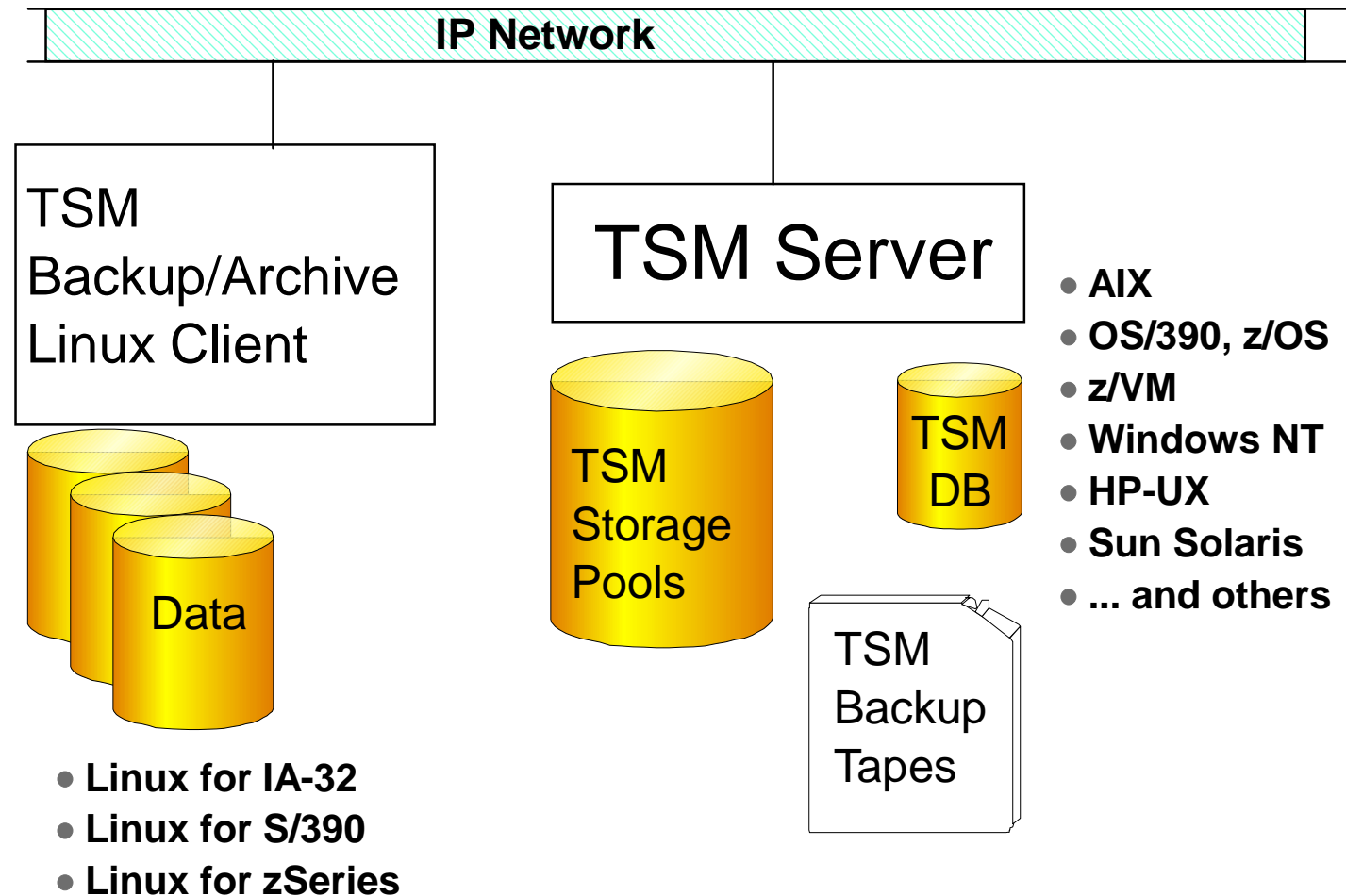
Tivoli Storage Manager: Linux-Intel

- **IA-32 TSM features**
  - ► Backup/Archive client
  - ► Admin client
  - ► Web client
  - ► API
- **Requirements**
  - ► Linux kernel 2.2.x or higher
  - ► RPM package
  - ► Certified distributions known to provide the base requirements:
    - – Red Hat 6.1, SUSE 6.3
    - – TurboLinux 6.0, Caldera 2.3

IA-32 = Intel Architecture 32-bit

3466 Network Storage Manager

A sophisticated Data Protection solution

Integrated hardware and software to provide a network/data protector

- **Lights-out operation**
- **Centralizes Backup/Recovery**
- **Enterprise-wide Administration, Monitoring and Reporting**
  - ✓ **Tivoli Storage Manager queries**
  - ✓ **Tivoli Storage Manager accounting records**
- **Attaches to tape library**

Tivoli SANergy File Sharing
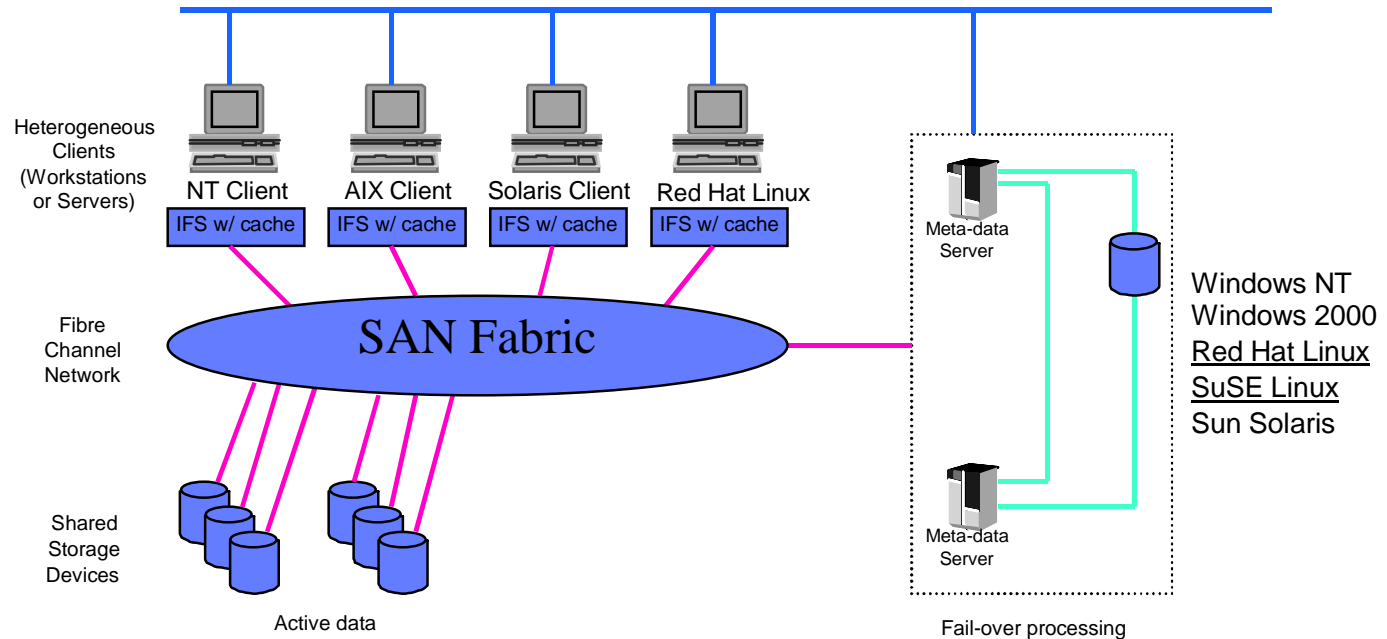
- FIle sharing capability of a LAN with the speed of a SAN
- Metadata server owns and formats the data
  - Metadata platforms: NY, W2K, Sun, Red Hat Linux-Intel
- SAN-based file sharing among heterogeneous servers
  - NT, W2K, Sun, AIX, MacOS, IRIX, Red Hat Linux-Intel, TRU64, DG/UX
- Improved performance vs. NAS filers

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Resources...

- **www.ibm.com/linux**
  - ▶ **Links to IBM Linux & open source sites**

- **www.ibm.com/storage**
  - ▶ **IBM Storage Hardware and Software**
  - ▶ **Specifications**
  - ▶ **System Requirements**
  - ▶ **Host attachments**

- **www.ibm.com/redbooks**
  - ▶ **IBM online publications and guide books**
  - ▶ **Implementing Linux with IBM Disk Storage**, SG24-6261
  - ▶ **Implementing IBM LTO in Linux and Windows Environments**, SG24-6268

- **www.tivoli.com**
  - ▶ **Overview of Tivoli software product suite**

HOWTO's for DFSMSdss and DFSMShsm!

Summary

► **IBM is committed to support LINUX across its server platforms**

► **IBM leads the industry in storage networking based on open, industry standards**

► **IBM delivers world-class disk and tape storage hardware, storage management software, and integrated solutions**

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