Linux and IBM Storage

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Agenda

- Linux Overview
- eServer Platforms
- Storage Connectivity Options
- IBM Storage Offerings
  - Disk Storage
  - Tape Storage
- Storage Management
- Resources
Open e-business platform

An Integrated Standards and Open Source Model
Linux Momentum Building

2000 New Server OS Shipments

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

New Server OS License Forecast (00 - 05)

- Linux 23.6% Growth
- Windows NT 16.5% Growth

Source: IDC, 2001
Thousands of applications have been ported to Linux

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

**Middleware**
- Red Hat
- SuSE
- TurboLinux
- Caldera
- ... others

**Distribution Tools and Utilities**
- Kernel 2.2.x
- Kernel 2.4.x
- Intel Architecture IA-32, IA-64
- PowerPC (Power3, Power4)
- S/390 (aka zSeries)
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
The Point of Coexistence - Where Linux Complements Integrated e-business Solutions

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
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 for S/390 for 32-bit architecture
  - Linux for zSeries for 64-bit architecture
  - 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
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
- Block I/O optimization
- High Performance & Scalability
- Fibre Channel protocols
- Longer design and installation time
- Typically more expensive
- Requires significant IT support

### iSCSI
- 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

### NAS
- 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

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"Storage Grid"  "File Grid"
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

- xSeries
- pSeries
- iSeries
- zSeries

Protocol

- SCSI
- FCP
- ESCON
- FICON

Subsystem

- SSA Port
- SCSI Port
- Native FC Port
- ESCON Port
- FICON Port

SAN Data Gateway

SAN Data Gateway for Serial Disk

FC Switch

ESCON Director

FICON Director

FICON Bridge
IP Network Connectivity

Data Client

- 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

- Hypertext Transfer Protocol (HTTP) including FTP

Data Server

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

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

- HTTP File Server

NAS

- iSCSI client (iClient) driver

iSCSI

- iSCSI storage subsystem or gateway to SAN devices
IBM Storage Offerings

- Questions for customers to ask a storage vendor

- IBM Disk Storage
  - Expandable Storage Plus
  - Fibre Array Storage Technology (FASdT)
  - 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 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
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
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
Example Configurations

Protocol

Adaptec 2944

xSeries Netfinity

Linux IA-32
Red Hat 7.1
Kernel 2.4.x

UltraSCSI Port

Enterprise Storage Server

ESCON Adapter

ESCON Director

ESCON Port

Enterprise Storage Server

Linux-ready Netfinity servers are perfect for use with IBM's Enterprise Storage Server using Fibre Channel attachment

Linux-ready mainframes are perfect for use with IBM's Enterprise Storage Server using ESCON attachment
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

- **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)
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

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

Linux support:
- 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
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
tvolser=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
Linux volumes can be varied online to OS/390 and z/OS.

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

Kernel 2.4.5
Linux on S/390 Compatible Disk Layout

Linux administrators:
- unmount
- remount partitions as read-only
- Submit JCL using FTP type site=JES
- remount for read-write

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

DFSMSdss and DFSMSHsm backup the data to tape

Kernel 2.4.5
Tivoli Storage Manager (TSM)

IP Network

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

TSM Storage Pools

TSM DB

TSM Backup Tapes

TSM Backup/Archive Linux Client
- Linux for IA-32
- Linux for S/390
- Linux for zSeries

Data
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
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
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
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 DFSMSShsm!
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