What's New in Linux on System z

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IBM Lab Boeblingen, Germany
Agenda

- What's new in System z
  - Distributions
  - Common code news
  - System z contributions
Distributions
Linux on System z distributions (Kernel 2.6 based)

- Novell SUSE Linux Enterprise Server 9 (GA 08/2004)
  - Kernel 2.6.5, GCC 3.3.3, Service Pack 4 (GA 12/2007)
- Novell SUSE Linux Enterprise Server 10 (GA 07/2006)
  - Kernel 2.6.16, GCC 4.1.0, Service Pack 3 (GA 09/2009)
- Novell SUSE Linux Enterprise Server 11 (GA 03/2009)
  - Kernel 2.6.27, GCC 4.3.3
- Red Hat Enterprise Linux AS 4 (GA 02/2005)
  - Kernel 2.6.9, GCC 3.4.3, Update 8 (GA 05/2009)
- Red Hat Enterprise Linux AS 5 (GA 03/2007)
  - Kernel 2.6.18, GCC 4.1.0, Update 4 (GA 09/2009)
- Others
  - Debian, Slackware, CentOS, Gentoo
  - Support may be available by some third party
## Supported Linux distributions

From: [http://www-03.ibm.com/systems/z/os/linux/support/support_testedplatforms.html](http://www-03.ibm.com/systems/z/os/linux/support/support_testedplatforms.html)

<table>
<thead>
<tr>
<th>Distribution</th>
<th>System z10</th>
<th>System z9</th>
<th>zSeries</th>
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<tr>
<td>RHEL 5</td>
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<tr>
<td>SLES 9</td>
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### 64-bit environment

<table>
<thead>
<tr>
<th>Distribution</th>
<th>System z10</th>
<th>System z9</th>
<th>zSeries</th>
</tr>
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<td>SLES 11 (1)</td>
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<td>SLES 10 (1)</td>
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<tr>
<td>SLES 9</td>
<td>✓</td>
<td>✓</td>
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</table>

(1) A 64-bit distribution does not run in a 31-bit environment; note that 31-bit applications can be run on a 64-bit distribution using the 31-bit emulation layer.
Linux on System z development process

- Open Source Community
- IBM Linux on System z development
- developerWorks web site
- Linux Distribution Partners
- Customers
Common Code
Kernel news – common code

- **Linux version 2.6.27 (2008-10-09)**
  - Lockless page cache
  - ubifs – unsorted block image filesystem for raw flash media
  - Multiqueue networking
  - ftrace - function tracer

- **Linux version 2.6.28 (2008-12-24)**
  - ext4 filesystem
  - Memory management scalability improvements
  - Unified trace buffer for ftrace, etc.

- **Linux version 2.6.29 (2009-03-23)**
  - btrfs and squashfs filesystems (experimental)
  - Security module hooks for path based access control (AppArmor, Tomoyo)
  - Credential records reorganized
Kernel news – common code

- Linux version 2.6.30 (2009-06-09)
  - Reliable Datagram Sockets (RDS) protocol support
  - EXOFS, a filesystem for Object-Based Storage Devices (experimental)
  - FS-Cache, a caching filesystem for networking file systems
  - Filesystems performance improvements

- Linux version 2.6.31 (2009-09-09)
  - Performance counters / events
  - kmemcheck, kmemlead
  - ftrace function tracer extensions
  - Per partition blktrace
  - gcov (GCC coverage testing tool) support
Current Linux kernel development

6,400 lines added
3,300 lines removed
1,700 lines modified
per day since 2.6.24

Source: Greg KH, …
www.linuxfoundation.org/publications/whowriteslinux.pdf
Current Linux kernel development

Most active kernel 2.6.30 companies
(Source: [http://lwn.net/Articles/334721/](http://lwn.net/Articles/334721/))

<table>
<thead>
<tr>
<th>By change-sets</th>
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<td><strong>(Unknown)</strong></td>
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<tr>
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<td><strong>118095</strong></td>
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<tr>
<td>Intel</td>
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<td>Red Hat</td>
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<tr>
<td><strong>IBM</strong></td>
<td>LinSysSoft Techn.</td>
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<tr>
<td>(Consultant)</td>
<td>ADDI-DATA GmbH</td>
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<tr>
<td>Oracle</td>
<td>Broadcom</td>
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<tr>
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<tr>
<td>HP</td>
<td>LSI Logic</td>
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<td>Wolfson Microel.</td>
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<td>(Academia)</td>
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<tr>
<td>Nokia</td>
<td>Freescale</td>
</tr>
<tr>
<td>XenSource</td>
<td>PetaLogix</td>
</tr>
</tbody>
</table>

- By change-sets:
  - Red Hat: 1305 (11.1%)
  - (Unknown): 1184 (10.1%)
  - Intel: 855 (7.3%)
  - Novell: 832 (7.1%)
  - IBM: 630 (5.4%)
  - (Consultant): 293 (2.5%)
  - Atheros Comm.: 262 (2.2%)
  - Oracle: 252 (2.1%)
  - University of Virg.: 227 (1.9%)
  - Fujitsu: 217 (1.8%)
  - Vyatta: 204 (1.7%)
  - Renesas Techn.: 152 (1.3%)
  - NTT: 121 (1.0%)
  - MontaVista: 115 (1.0%)
  - HP: 107 (0.9%)
  - Wolfson Microel.: 105 (0.9%)
  - (Academia): 102 (0.9%)
  - Nokia: 98 (0.8%)
  - XenSource: 91 (0.8%)

- By lines changed:
  - (Unknown): 181413 (13.6%)
  - Novell: 164229 (12.3%)
  - (None): 118095 (8.9%)
  - Intel: 86060 (6.5%)
  - Red Hat: 73954 (5.5%)
  - LinSysSoft Techn.: 64798 (4.9%)
  - ADDI-DATA GmbH: 43420 (3.3%)
  - SofaWare: 39245 (2.9%)
  - Broadcom: 31956 (2.4%)
  - AMD: 28364 (2.1%)
  - Entropy Wave: 25905 (1.9%)
  - IBM: 25702 (1.9%)
  - Oracle: 25588 (1.9%)
  - NTT: 25235 (1.9%)
  - Neterion: 23495 (1.8%)
  - LSI Logic: 22304 (1.7%)
  - Atheros Comm.: 21627 (1.6%)
  - (Consultant): 19209 (1.4%)
  - Freescale: 16139 (1.2%)
  - PetaLogix: 15846 (1.2%)
# Linux Kernel contributions since 2.6.24 (by changesets)

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<th>Company Name</th>
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<th>Percent of Total</th>
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<td>Fujitsu</td>
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<tr>
<td>...</td>
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</tbody>
</table>

Linux kernel has approx. 11.5 million lines of code.
System z contributions
Linux Kernel - System z contributions

Kernel version

Patches s390 / s390x

Patches overall

0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100 1150 1200

0 .11 .12 .13 .14 .15 .16 .17 .18 .19 .20 .21 .22 .23 .24 .25 .26 .27 .28 .29 .30 .31
System z kernel features – z10 support

- CPU node affinity (kernel 2.6.25)
  - With this feature the kernel uses CPU topology information as supplied by the IBM System z10. This information is used by the scheduler to build scheduling domains and should increase overall performance on SMP machines.
  - This support is available only on IBM System z10, when running Linux on System z in an LPAR.

- Vertical CPU management (kernel 2.6.25)
  - With this feature it is possible to switch between horizontal and vertical CPU polarization via a sysfs attribute.
  - If vertical CPU polarization is active then the hypervisor will dispatch certain CPUs for a longer time than other CPUs for maximum performance.
  - There are three different types of vertical CPUs: high, medium and low. "Low" CPUs get hardly any real CPU time, while "high" CPUs get a full real CPU; "medium" CPUs get something in between.
  - By default the old horizontal CPU polarization is active.
  - This support is available only on z10, running Linux on System z in an LPAR.
System z kernel features – z10 support

- Large page support - with large page emulation on older hardware (kernel 2.6.25)
  - This adds hugetlbfs support on System z, using both hardware large page support if available (IBM System z10), and software large page emulation (with shared hugetlbfs pagetables) on older hardware.
  - Exploitation of the IBM System z10 hardware large page support is only available when running Linux on System z in an LPAR.

- STSI change for capacity provisioning (kernel 2.6.25)
  - Make the permanent and temporary capacity information as provided by the STSI (store system information) instruction of the IBM System z10 available to user space via /proc/sysinfo.
  - Using this support when running Linux on System z on IBM System z10 as a VM guest requires z/VM 5.3
System z kernel features – z10 support

- Support for hardware accelerated crypto (kernel 2.6.25)
  - Add support for the new hardware accelerated crypto algorithms.
  - The new algorithms are SHA-512 (including SHA-384) and AES-192, AES-256.
  - This support is available only on IBM System z10, running Linux on System z in an LPAR or as a VM guest.
  - The new algorithms have been added to the in-kernel crypto API.
  - The new algorithms have been added to the user space library libica 1.3.9 which is part of openCryptoki, see http://opencryptoki.sourceforge.net/.

- System z HiperSockets layer-2 support (kernel 2.6.25)
  - HiperSockets are enhanced to support layer-2 functionality.
  - The existing OSA layer-2 support is utilized to enable HiperSockets layer-2. This includes IPv6 support for HiperSocket layer-2. Connecting layer-2 and layer-3 hosts is not supported by the System z firmware.
  - This support is available only on z10, running Linux on System z in an LPAR or as a VM guest (z/VM 5.2 or higher).
System z kernel features – channel subsystem

- **I/O configuration support (kernel 2.6.27)**
  - Adds the infrastructure to allow Linux system to change the I/O configuration of a System z machine.
  - Operations are addition, removal and reconfiguration/reassignment of I/O channels, control units and subchannels.
  - This support is available only when running Linux on System z in a special designated LPAR.

- **Modularization of qdio and thin interrupts (kernel 2.6.27)**
  - Make the thin interrupt layer independent from qdio and improve the code layering in the qdio module. This splits thin interrupts, memory queues and the initialization of the subchannels into separate, independent units.
System z kernel features – z/VM

- **Extra kernel parameter via VMPARM (kernel 2.6.27)**
  - Modify the IPL records to append extra parameters specified with the z/VM VMPARM option to the kernel command line.

- **Extra kernel parameter for SCSI IPL (> kernel 2.6.30)**
  - Modify the SCSI loader to append extra parameters specified with the z/VM VMPARM option to the kernel command line.

- **Support for enhanced z/VM DASD UIDs (kernel 2.6.27)**
  - Allows to distinguish between virtual devices (minidisks) provided by z/VM that reside on the same real device.
  - z/VM APAR VM64273 needs be installed to enable enhanced DASD IUDs.

- **Add vmconvert option to vmur tool (s390-tools 1.8.0)**
  - Simplify the copy of a z/VM dump from the z/VM reader to Linux
  - A single command does the job: vmur re <spoolid> -c <dump>
System z kernel features – z/VM

- **TTY terminal server over IUCV (kernel 2.6.29)**
  - Provide central access to the Linux console for the different guests of a z/VM.
  - The terminal server connects to the different guests over IUCV.
  - The IUCV based console is ASCII based.
  - Full-screen applications like editor vi are usable on the console.

- **AF_IUCV datagram sockets (kernel 2.6.30)**
  - Introduce AF_IUCV sockets of type SOCK_SEQPACKET that map read/write operations to a single IUCV operation. The socket data is not fragmented.
  - Former SOCK_STREAM data might be fragmented
  - The intention is to help application developers who write applications using the native IUCV interface, e.g. Linux to z/VSE.
System z kernel features – storage

- **DASD HyperPAV support (kernel 2.6.25)**
  - Parallel access volumes (PAV) is a storage server feature, that allows to start multiple channel programs on the same DASD in parallel. You have to define alias devices which can be used as alternative paths to the same disk.
  - HyperPAV is activated automatically when the necessary prerequisites are there: (DS8000 with HyperPAV LI and z/VM 5.3, when running Linux on System z as a VM guest)
  - See Document: "How to Improve Performance with PAV"

- **DASD: system information messages (kernel 2.6.25)**
  - With this feature the system reports system information messages (SIM) to the user. The System Reference Code (SRC), which is part of the SIM, is reported to the user and allows to look up the reason of the SIM online in the documentation of the storage server.

- **4G FICON Express support (test only)**
  - Ensure that the new 4G FICON links work with the existing DASD and zFCP drivers.
System z kernel features – storage

- **DASD Large Volume Support (kernel 2.6.30)**
  - Large Volume Support is a feature that allows to use ECKD devices with more than 65520 cylinders.
  - This feature is available with DS8000 R4.0
  - s390-tools support for large volumes is required.
  - See: http://www-03.ibm.com/systems/storage/disk/ds8000/

- **DASD High Performance FICON (kernel 2.6.30)**
  - Support access to a storage server attached using the I/O subsystem in transport mode.
  - This feature is available with DS8000 R4.1
  - Changes in DASD driver were necessary
  - See http://www-03.ibm.com/systems/storage/disk/ds8000/

- **DASD Format Record 0 (kernel 2.6.30)**
  - Allows to initialize unformatted disks on EMC storage arrays
System z kernel features – Storage

- **FCP performance data collection: I/O statistics (2.6.25)**
  - The FCP adapter statistics (available since IBM System z9) provide a variety of information about the virtual adapter (subchannel). In order to collect this information the zfcp device driver is extended on one side to query the adapter and on the other side summarize certain values which can then be fetched on demand. This information is made available via files (attributes) in the sysfs filesystem.

- **FCP performance data collection: adapter statistics (2.6.26)**
  - The zFCP adapter collects a number of statistics about the virtual adapter. This information is fetched by the driver and is exported to user space via sysfs.
  - This support is available only on IBM System z9 or later.

- **FCP performance data reports (s390-tools 1.8.0)**
  - Provide a formatted and evaluated view to the data delivered by the FCP data collection.
  - The tool-set ziimon is delivered as part of the s390-tools package version 1.8.0 and higher
System z kernel features – storage

- **FCP qdio rate improvements (test only)**
  - The ops/second rate of the zFCP adapter has been increased significantly (x2).
  - This support is available only on IBM System z9 GA3 or later.

- **FCP automated port discovery (kernel 2.6.25)**
  - Scan the connected fiber channel SAN and automatically activate all available and accessible target ports. This requires a proper SAN setup with zoning.

- **FCP LUN discovery tool (user space) - lsluns**
  - A command line tool to display the available LUNs for a specified remote-port.
  - A replacement for the functionality provided by the san-discovery tool based on the zFCP HBA-API.
System z kernel features – storage

- **FCP SCSI error recovery hardening (kernel 2.6.30)**
  - Avoid SCSI error recovery escalation in case of concurrent zfcp and SCSI error recovery.

- **FCP adjustable queue depth (> kernel 2.6.30)**
  - Customizable queue depth for SCSI commands in zfcp
  - In the past was at constant 32 queue entries
System z kernel features – networking

- Support two OSA ports per CHPID - four-port exploitation (kernel 2.6.25)
  - Exploit next OSA feature which offers two ports within one CHPID. The additional port number 1 can be specified with the qeth sysfs-attribute "portno".
  - This support is available only for OSA-Express3 GbE SX and LX on z10, running Linux on System z in an LPAR or as a VM guest (PTF for z/VM APAR VM64277 required).

- QETH componentization (kernel 2.6.25)
  - The qeth driver module is split into a core module and layer2-/layer3-specific modules.
  - The default operation mode for OSA-devices is changed to layer2; for HiperSockets devices the layer3 default-mode is kept.
  - For layer3 mode devices the existence of (possibly faked) ethernet headers is guaranteed to enable smooth integration of qeth devices into Linux.

- Secondary unicast addresses (kernel 2.6.27)
  - Allow secondary unicast MAC addresses to support MAC address based VLANs
  - This only works with an OSA interface running in layer 2 mode.
System z kernel features – crypto

- **Support for large random numbers (kernel 2.6.25)**
  - Allow user space applications to access large amounts of truly random data. The random data source is the built-in hardware random number generator on the CEX2C cards.

- **Generic algorithm fallback (kernel 2.6.25)**
  - Use software implementation of the in-kernel crypto library for key lengths not supported by hardware
  - Without the fallback support it is not possible to use in-kernel crypto with a key length that is not supported by the hardware module.

- **Cleanup of libICA crypto library**
  - Version 2.0 of the libICA library has been published with a set of simpler functions for the existing interfaces.
System z kernel features - usability

- Standby CPU activation/deactivation (kernel 2.6.25)
  - With this feature it is possible to make use of standby CPUs for instruction execution.
  - A CPU can be in one of the states "configured", "standby", or "reserved". Before a CPU can be used for instruction execution it must be in "configured" state. Previously, the kernel was limited to operate only with "configured" CPUs. With this feature it is possible to change the state of "standby" CPUs to "configured" state and vice versa via a sysfs attribute.
  - This support is available only on IBM System z10, when running Linux on System z in an LPAR.

- Shutdown Actions Interface (kernel 2.6.25)
  - The new shutdown actions interface allows to specify for each shutdown trigger (halt, power off, reboot, panic) one of the five available shutdown actions (stop, ipl, reipl, dump, vmcmd).
  - A sysfs interface under /sys/firmware is provided for that purpose.
  - Possible use cases are e.g. to specify that a vmdump should be automatically triggered in case of a kernel panic or the z/VM logoff command should be executed on halt.
System z kernel features - usability

- **Shutdown action IPL after dump (kernel 2.6.30)**
  - The new shutdown action `dump_reipl` is introduced. It combines the actions `dump` and `re IPL`, first a dump is taken, then a re-IPL of the system is triggered.

- **Dynamic memory add / remove (kernel 2.6.27)**
  - Use the SCLP interface to attach and detach storage elements to the image.
  - Provide the platform support for Linux memory add / remove interface.

- **Struct page elimination (kernel 2.6.26)**
  - Remove the need to allocate a “struct page” structure for pages of a DCSS.
  - No more “mem=” to include the memory areas of the DCCS segments in the memory map.
System z kernel features – usability / RAS

- **Suspend / resume support (> kernel 2.6.30)**
  - Add the ability to stop a running Linux system and resume operations later on. The image is stored on the swap device and does not use any system resource while suspended.
  - Only suspend to disk is implemented, suspend to RAM is not supported.

- **Add Call Home data on halt and panic if running in LPAR (> kernel 2.6.30)**
  - Report system failures (kernel panic) via the service element to the IBM service organization.
  - Improves service for customers with a corresponding service contract.
  - Opt-in, by default this feature is deactivated.
System z kernel features - miscellaneous

- STP Support (kernel 2.6.27)
  - Support for clock synchronization using the server time protocol (STP)
  - This support is available only when running Linux on System z in an LPAR.

- Kernel vdso support (kernel 2.6.29)
  - Kernel provided shared library maps to speed up a few system calls
    (gettimeofday, clock_getres, clock_gettime)
System z kernel features – message documentation

- Document all System z related kernel messages
  - Cleanup messages in System z related code (kernel 2.6.27/2.6.30)
  - Script to generate a man page for every kernel message (rejected)
  - Distributors generate man pages for their distributions (up to distributor)

```
xpram.ab9aa4(9)

Message
xpram.ab9aa4: %d is not a valid number of XPRAM devices

Severity
Error

Parameters
@1: number of partitions

Description
The number of XPRAM partitions specified for the 'devs' module parameter or with
the 'xpram.parts' kernel parameter must be an integer in the range 1 to 32. The
XPRAM device driver created a maximum of 32 partitions that are probably not con-
figured as intended.

User action
If the XPRAM device driver has been compiled as a separate module, unload the mod-
ule and load it again with a correct value for the into the kernel, correct the
'xpram.parts' parameter in the kernel command line and restart Linux.

LINUX                           Linux Messages                 xpram.ab9aa4(9)
```
GNU GCC compiler

- General optimizer improvements
  - New data flow analyzer framework (GCC 4.3)
- System z machine support
  - System z10 processor support (GCC 4.4)
    - Exploit instruction new to z10
    - Selected via -march=z10 / -mtune=z10
  - Decimal floating point support (GCC 4.3)
    - For newer machines with hardware DFP support
  - 64 bit registers for 31 bit applications (> GCC 4.4)
    - Work in progress, harder than it looks
- System z compiler performance
  - Overall enhancement > 10% on z9 with industry-standard integer benchmark
    - 8% comparing GCC 3.4 and GCC 4.1
    - 5.9% comparing GCC 4.1 and GCC 4.2
    - 0.5% comparing GCC 4.2 and GCC 4.3
Linux kernel - direction of development

- Diversity: now 21 architectures (27 w/o unification)
  - alpha (64 bit), arm (32 bit), avr32 (32 bit), blackfin (32 bit), cris (32 bit), frv (32 bit), h8300 (32 bit), ia64 (64 bit), m32r (32 bit), m68k (32 bit), m68knommu (32 bit), mips (32/64 bit), mn10300 (32 bit), microblaze (32bit), s-core (32 bit) pa-risc (32 bit), powerpc (32/64 bit), s390 (32/64 bit), sh (32/64 bit), sparc (32/64 bit), x86 (32/64 bit), xtensa (32 bit)
- Emphasis on larger, more powerful machines
- New, improved filesystems
- Virtualization (KVM, paravirt, XEN), continues to attract a lot of attention

Linux is Linux, but
Features, properties and quality differ dependent on your platform
Useful Web links

www.ibm.com/developerworks/linux/linux390

www.ibm.com/developerworks/linux/linux390/whatsnew

www.ibm.com/developerworks/linux/linux390/development_recommended

www.ibm.com/developerworks/linux/linux390/kernel

www.ibm.com/developerworks/linux/linux390/s390-tools

www.ibm.com/developerworks/linux/linux390/other_packages

www.ibm.com/developerworks/linux/linux390/distribution_hints

www.ibm.com/developerworks/linux/linux390/perf/tuning_papers

http://publib.boulder.ibm.com/infocenter/lnxinfo/v3r0m0/index.jsp
Thank you for your interest!