

2009 System z Expo

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What's New in Linux on System z

zLG01

Ursula Braun (ursula.braun@de.ibm.com)

IBM Germany Research and Development

Linux on System z Development

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Agenda



- Linux on System z Distributions
- Linux Common Code news
- What's New in System z
 - Kernel
 - GCC
 - s390-tools
 - Other tools

Distributions

z/VM Virtual Network

Linux on System z distributions (Kernel 2.6 based)

- **SUSE Linux Enterprise Server 9 (GA 08/2004)**
 - Kernel 2.6.5, GCC 3.3.3, Service Pack 4 (GA 12/2007)
- **SUSE Linux Enterprise Server 10 (GA 07/2006)**
 - Kernel 2.6.16, GCC 4.1.0, Service Pack 2 (GA 05/2008)
- **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,
 - 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

Hardware platform and operating system software compatibility

64-bit environment

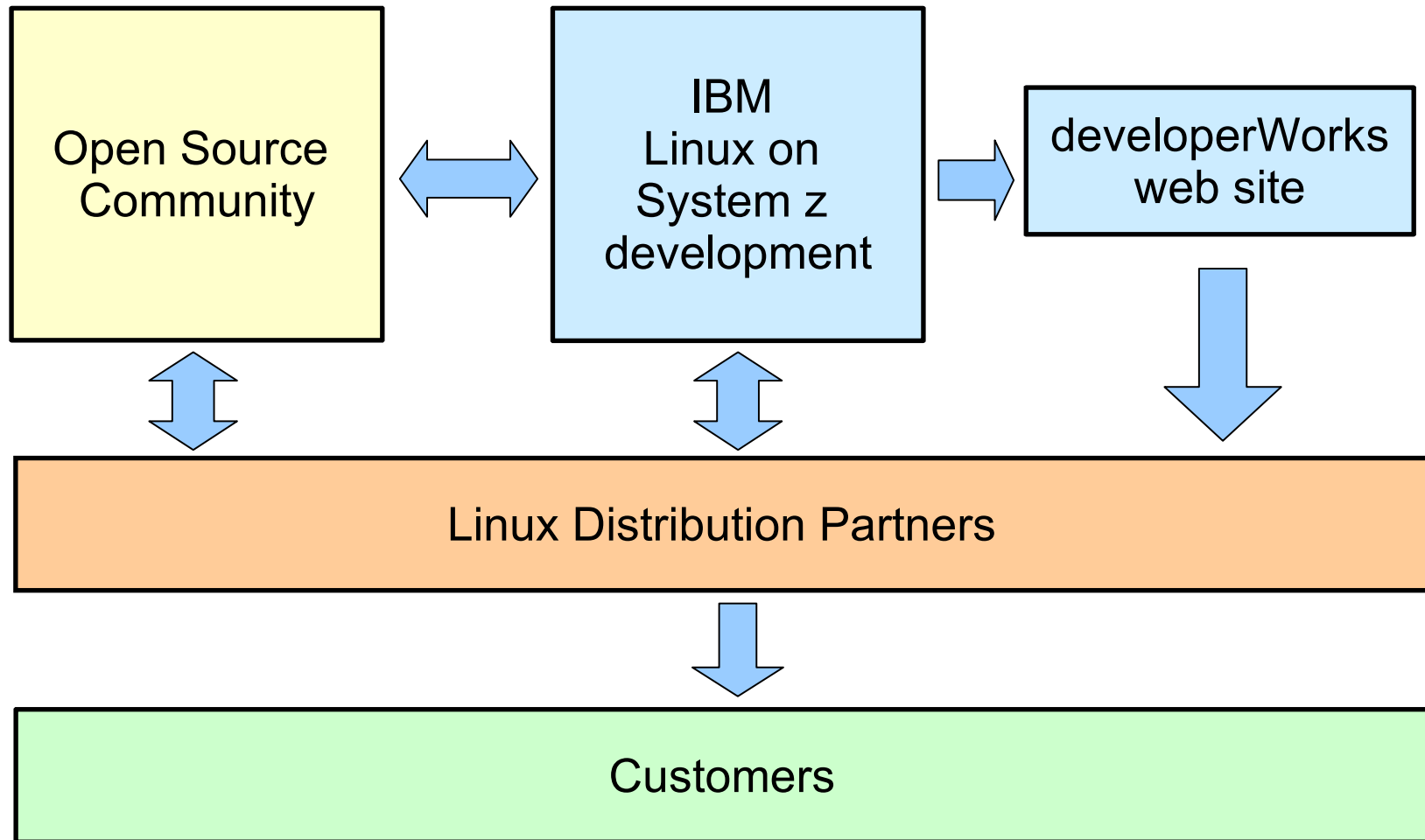
Distribution	System z 10	System z 9	z Series
RHEL 5	✓	✓	✓
RHEL 4	✓	✓	✓
RHEL 3	—	*	✓
SLES 11	✓	✓	✗
SLES 10	✓	✓	✓
SLES 9	✓	✓	✓

31-bit environment

Distribution	System z 10	System z 9	z Series
RHEL 5 (1)	—	—	—
RHEL 4	✓	✓	✓
RHEL 3	—	*	✓
SLES 11 (1)	—	—	—
SLES 10 (1)	—	—	—
SLES 9	✓	✓	✓

(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



Common Code

z/VM Virtual Network

Kernel news – Common code

- **Linux version 2.6.27 (2008-10-09)**
 - Lockless page cache
 - Ubifs filesystem for 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 LLTng, ftrace, etc.
- **Linux version 2.6.29 (2009-03-23)**
 - Btrfs and squashfs filesystems
 - Security module hooks for path based access control (AppArmor, Tomoyo)
 - Credential records

Kernel news – Common code

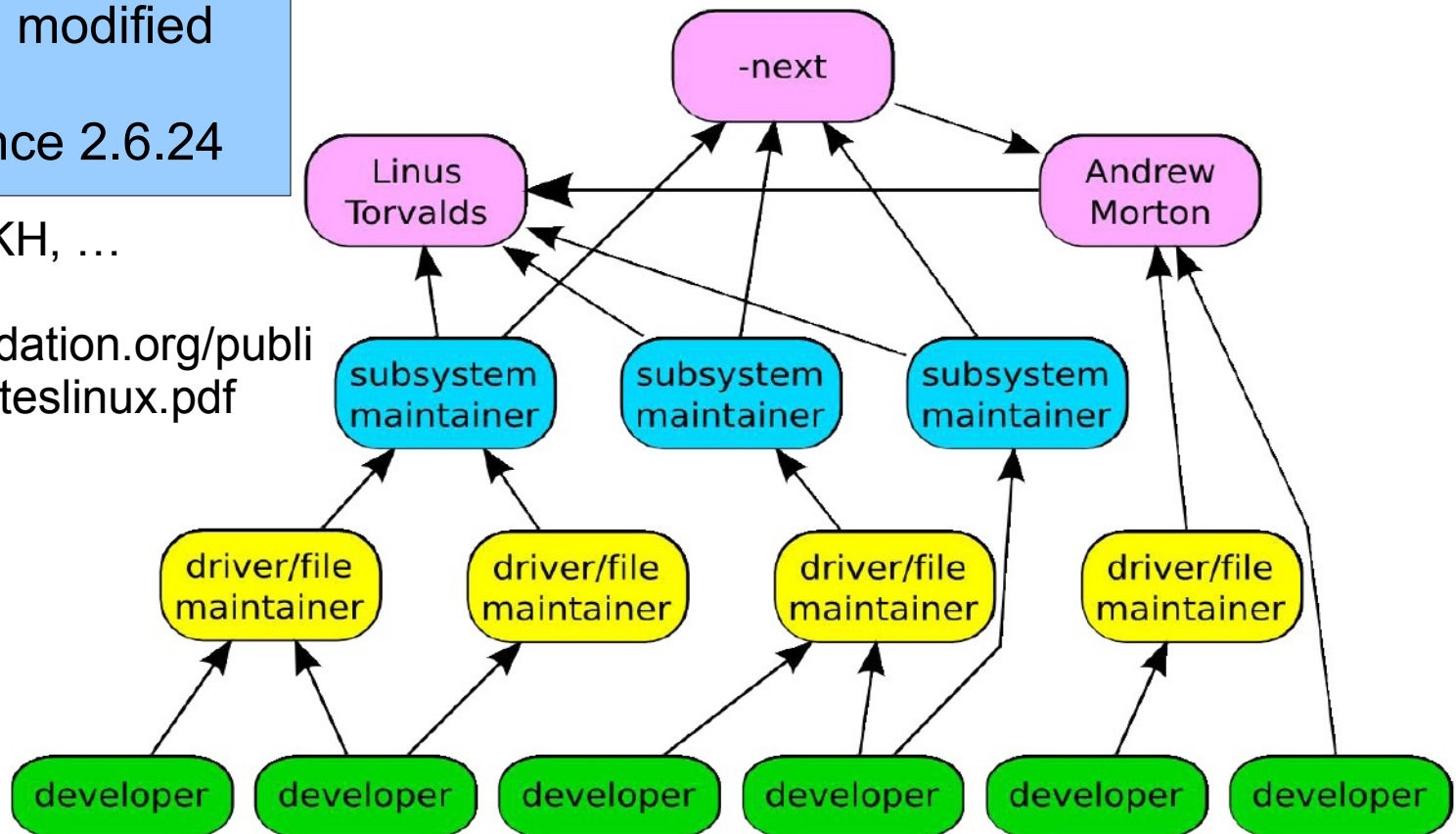
- **Linux version 2.6.30 (2009-06-09)**
 - Reliable Datagram Sockets (RDS) protocol support
 - EXOFS, a filesystem for Object-Based Storage Devices
 - FS-Cache, a caching filesystem
 - Filesystems performance improvements
- **Linux version 2.6.31 (2009-09-09)**
 - Performance counters / events
 - Kmemcheck, Kmemleak
 - Ftrace function tracer extensions
 - Per partition blktrace
 - Gcov 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 2.6.30 employers (Source:<http://lwn.net/Articles/334721/>)

By changesets

(None)	1970	16.8%
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)

Company Name	Number of Changes	Percent of Total
None	13,850	21,1%
RedHat	7,897	12,0%
IBM	4,150	6,3%
Novell	4,021	6,1%
Intel	3,923	6,0%
Unknown	2,765	4,2%
Oracle	2,003	3,1%
Consultant	1,480	2,3%
Parallels	1,142	1,7%
Fujitsu	1,007	1,5%
Academia	992	1,5%
Analog Devices	889	1,4%
Renesas Technology	884	1,3%
SGI	755	1,2%
Movial	738	1,1%
Sun	639	1,0%

Linux Kernel Directions

- 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

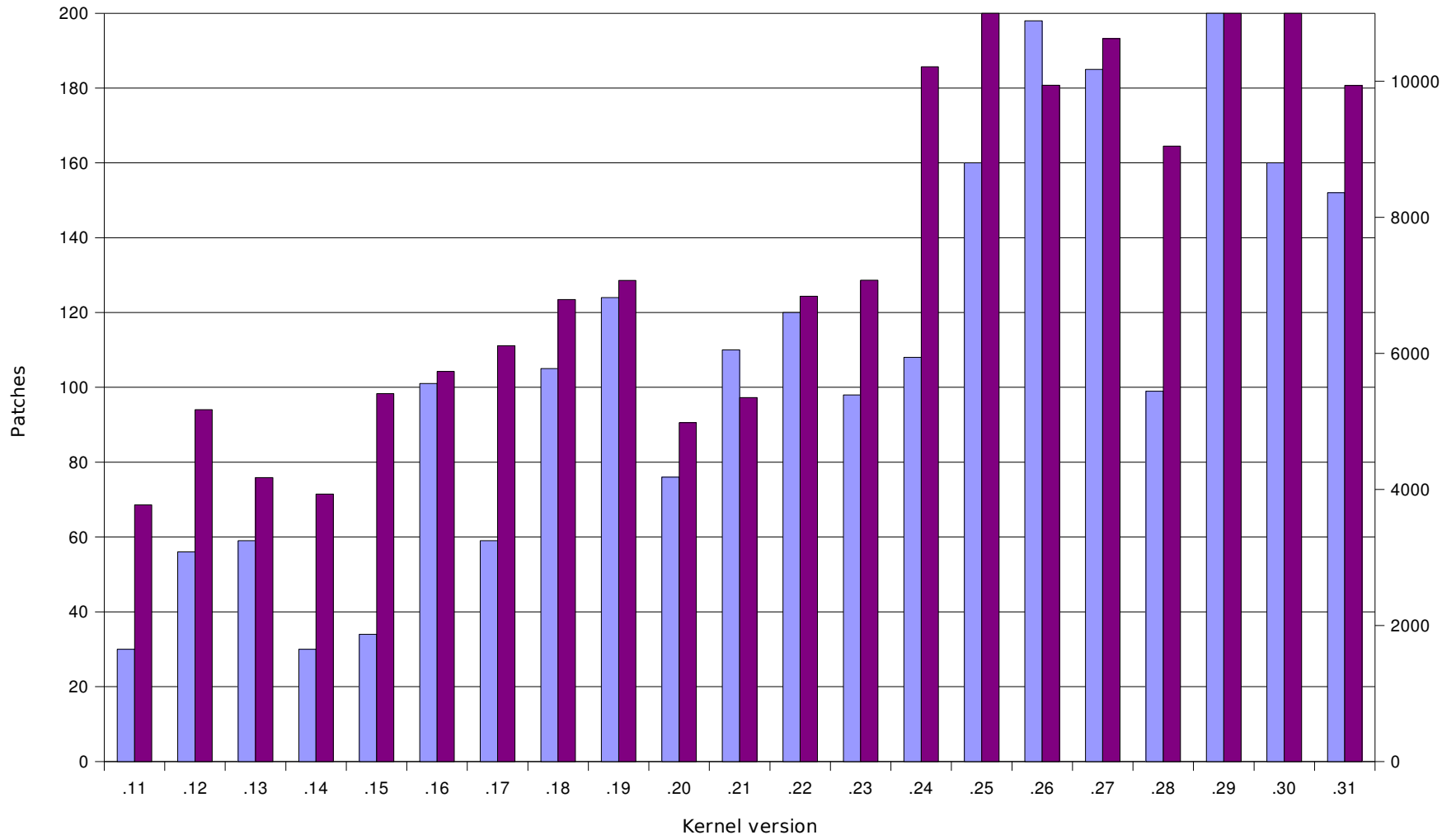
Linux is Linux, but

Features, properties and quality differ dependent on your platform

System z contributions

z/VM Virtual Network

Linux Kernel - System z contributions



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.



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■ 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.



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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.



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■ STSI change for capacity provisioning (kernel 2.6.25)

- Make the permanent and temporary capacity information as provided by the STSI 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



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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 with kernel version 2.6.25.
- 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/>.



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■ **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 later).



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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 system.
- 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 an 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 UUIDs (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 reader to Linux
 - A single command does the job: `vmur re <spoolid> -c <dump>`



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System z kernel features – z/VM



5.4

■ 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.
- Fullscreen applications like *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.
- 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. It defines 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"



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■ 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.



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■ 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 features 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 features is available with DS8000 R4.1
- See <http://www-03.ibm.com/systems/storage/disk/ds8000/>

■ **DASD Format Record 0 (kernel 2.6.30)**

- Allows to initialized unformatted disks on EMC storage arrays



5.4

System z kernel features – Storage

■ FCP performance data collection: I/O statistics (2.6.25)



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- 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 zfcplib 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)



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- 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)



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- Provide a formatted and evaluated view to the data delivered by the FCP data collection.
- The toolset *ziimon* is delivered as part of the s390-tools package version 1.8.0
- See <http://www.ibm.com/developerworks/linux/linux390/s390-tools-1.8.0.html>



5.4

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.



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■ FCP LUN discovery tool (user space) - *Isluns*

- 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.



5.4

System z kernel features – Storage

- **FCP SCSI error recovery hardening (kernel 2.6.30)**
 - Avoid SCSI error recovery escalation in case of concurrent zfcplib and SCSI error recovery.
 -
- **FCP adjustable queue depth (> kernel 2.6.30)**
 - Customizable queue depth for SCSI commands in zfcplib

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).



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▪ **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.



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▪ **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.



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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.



5.3



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▪ **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.



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▪ **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.
- See <http://sourceforge.net/projects/opencryptoki/>

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.



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5.4

■ 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.



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5.4

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.



5.4

■ 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.



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■ 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 DCSS segments in the memory map.



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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 features is deactivated.

System z kernel features - Misc

▪ **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 to speed up a few system calls (gettimeofday, clock_gettime, clock_getres)



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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)



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```

xpram.ab9aa4 (9)                                     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 Compiler

■ General optimizer improvements

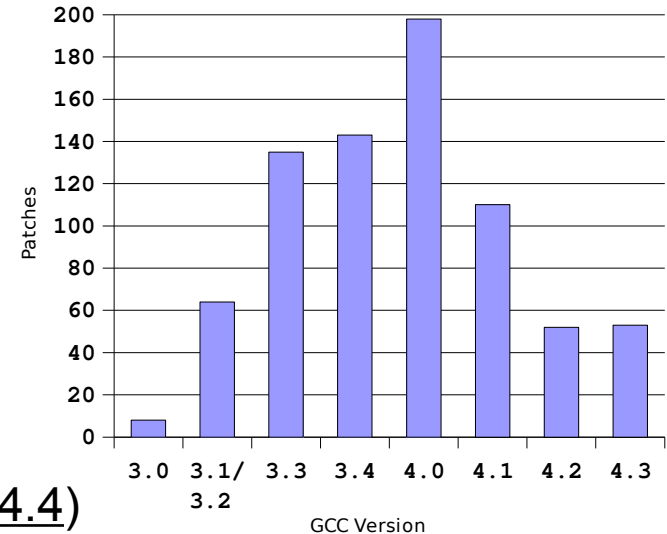
- New data flow analyzer framework (GCC 4.3)

■ 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



s390-tools

- s390-tools is a package with a set of user space utilities to be used with Linux on System z.
- See: <http://www.ibm.com/developerworks/linux/linux390/s390-tools-1.8.1.html>
- Recent changes:
 - **Cpuplugd** – s390-tools 1.6.3
A daemon that manages CPU and memory based on a set of rules
 - **New option -x/--extended-uid for dasdinfo** – s390-tools 1.7.0
With the PTF for APAR VM64273 installed, z/VM provides a unique identifier that allows to distinguish between virtual disks which are defined on the same real device. This identifier will be part of the uid. To allow for an easier upgrade, the original -u/--uid option will print the uid without this token and the -x/--extended-uid will return the full uid.
 - **zipl IPL-retry on IFCC** – s390-tools 1.7.0
This feature causes the hardware to retry a CCW IPL operation on an alternate channel-path if an interface-control check is detected during execution of the CCW IPL operation.

s390-tools (cont)

- More change in s390-tools version 1.7.0
 - **Replacement of the kernel parameter string in the zipl menu**
zipl's boot menu for DASD devices has been changed to allow replacing the complete kernel parameter string with user input when the first character of user input is an equals sign ('=').
 - **Add VMCMD support to dumpconf**
The dumpconf init script now exploits the new "shutdown actions interface" introduced with upstream linux kernel 2.6.25. Up to five VM commands can be specified to be triggered in case of a kernel panic.
 - **mon_fsstatd: Remove init script and sysconfig file**
mon_fsstatd init script and sysconfig file are replaced by mon_statd, which controls both monitor daemons mon_fsstatd and mon_procd.
 - **lszfc: Source code cleanup (No external interfaces changed.)**

s390-tools (cont)

■ More change in s390-tools version 1.8.0

– **New tools:**

- **IPL tools:** A set of shell scripts `chreipl`, `chshut`, `lsreipl`, and `lsshut` to query and configure the shutdown actions
- **ziomon tools:** The toolset to format the data delivered by the FCP data collection: `ziorep_config`, `ziorep_utilization`, `ziorep_traffic`
- **FCP:** List available SCSI LUNs with the `lsluns` script
- **Crypto tools:** Two shells scripts `lszcrypt` and `chzcrypt` to query and modify the configuration of the `zcrypt` driver.

– **Changes:**

- **New qeth driver:** add support for the new `qeth` driver to the `ip_watcher` and `osasnmpd` tools
- **Cio layer:** Add support for non I/O subchannels to `lscss`
- **Disk encryption:** query the disk encryption status for `dasd` (`dasdview`) & `zfcplib` (`lsluns`)
- **SCSI tape:** Add SCSI tape support to `lstape`
- **FCP dumper:** Add support for memory holes to `zfcplibdump_v2`
- **zipl:** Add support for virtio devices and multi volume dumps

s390-tools (cont)

- More change in s390-tools version 1.8.1



5.4

- **New tools:**

- **iucvterm:** z/VM IUCV terminal application, a set of tools to provide to provide terminal access via the IUCV TTY.

- **Changes:**

- **dasdfmt, fdasd, zipl:** Add support for large volumes
- **dasdfmt:** Add `–norecordzero` and `–percentage` options
- **dasdview:** Add `–characteristic` option
- **dumpconf, zfcpdump, zipl:** Add support for automatic `ipl` after `dump`
- **Isluns:** Add `–active` option
- **tunedasd:** Normalize profile data
- **vmur:** Add `–vmconvert` option
- **ziomontools:** Add report utilities for performance data report generation

Other tools

- Experimental (unsupported) userspace sample kuli 1.0.0 demonstrating KVM usage (2008-07-04)
 - kuli" is an experimental (unsupported) userspace sample to demonstrate that KVM can be used to run virtual machines on Linux on System z.
 - This experimental proof of concept is unsupported and should not be used for any production purposes.
- System Loader (sysload) 1.0.0 for Linux on System z.(2008-05-16)
 - System Loader uses a minimal RAM disk based Linux system to run a boot loader application and kexec to boot the final Linux system.
 - zipl from s390-tools is required as a first stage boot loader.
 - Benefits of the System Loader sysload:
 - no need to re-initialize after kernel update
 - flexible boot menu
 - network-based boot via ftp, http, ssh
 - can be used as a generic rescue system
- http://www.ibm.com/developerworks/linux/linux390/other_packages.html

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>
 - IBM Information Center for Linux

Thank you for your interest !

Help

