



IBM Linux and Technology Center

# What's New in Linux on System z

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# IBM collaborates with the Linux community

- has been an active participant since 1999
- is one of the leading commercial contributors to Linux
- has over 600 full-time developers working with Linux and open source

## Linux Kernel & Subsystem Development

Kernel Base  
Security  
Systems Mgmt  
Virtualization  
Filesystems,  
and more...

## Expanding the Open Source Ecosystem

Apache  
Eclipse  
Mozilla Firefox  
OpenOffice.org,  
and more...

## Promoting Open Standards & Community Collaboration

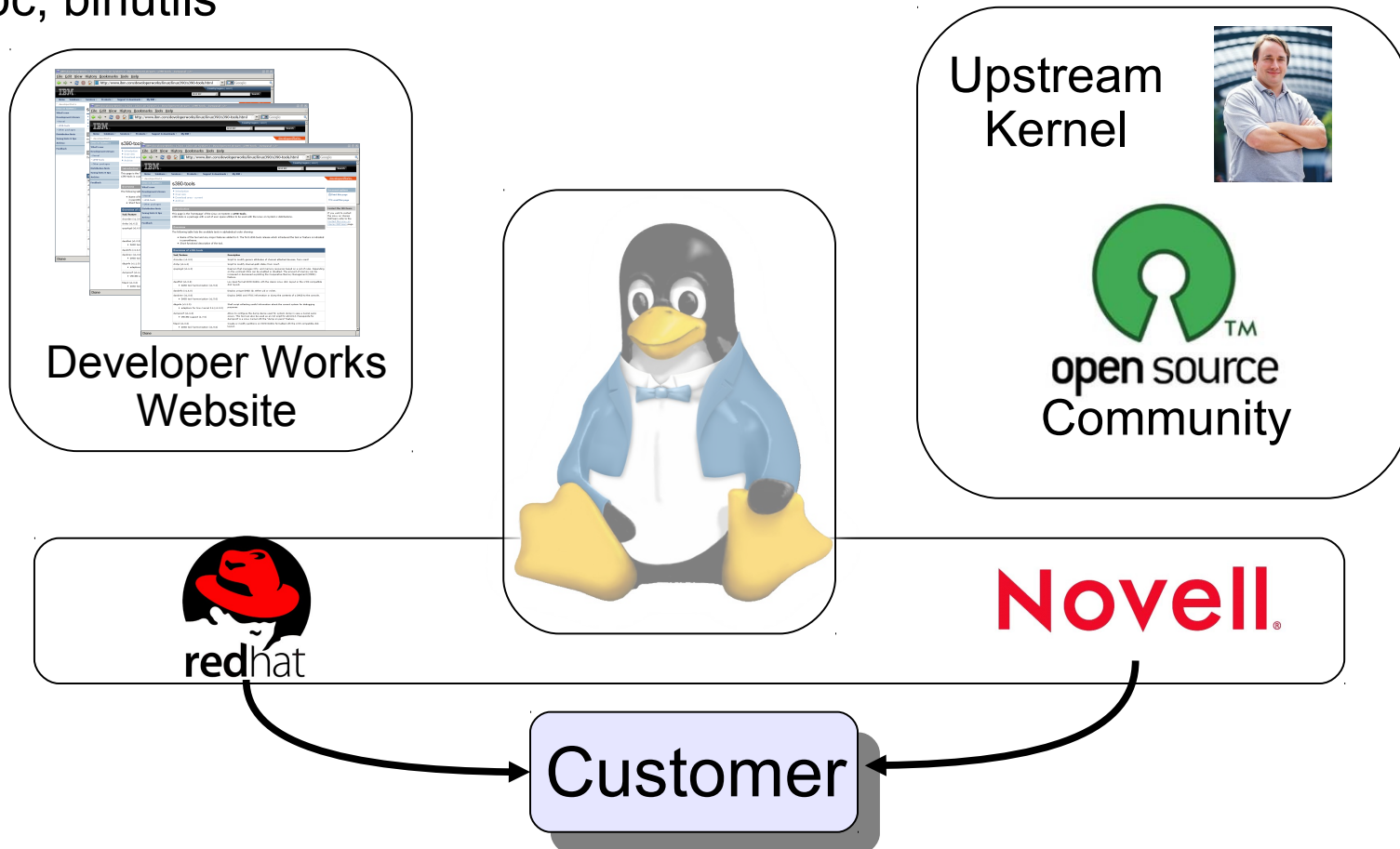
The Linux Foundation  
Linux Standards Base  
Common Criteria certification,  
and more...

## Foster and Protect the Ecosystem

Software Freedom Law Center  
Free Software Foundation (FSF),  
and more...

# The IBM Linux development process

- IBM Linux on System z development contributes in the following areas: Kernel, s390-tools, open source tools (e.g. eclipse, ooprofile), gcc, glibc, binutils



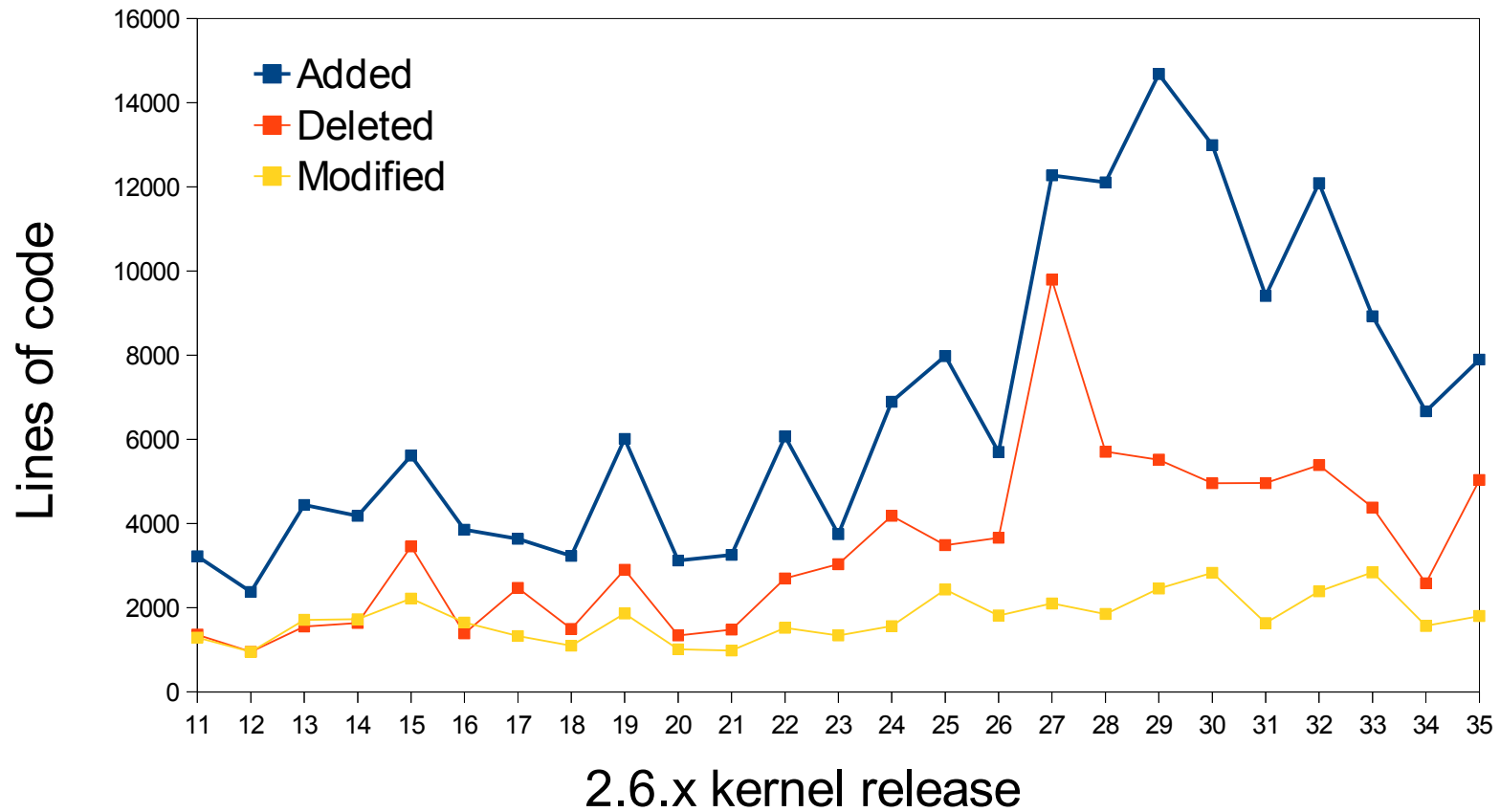
## Facts on Linux

- 2009, **75%** of the Linux code was developed by **programmers working for corporations**.
- **\$1.14 billion**: estimated total value of the **Linux kernel 2.6.30**
- **\$7.37 billion**: projected cost to produce the 283 million lines of code which are contained in **Linux Distribution** in a **commercial environment**.
- IDC forecasts show that **Linux server revenue will grow by 85.5%** between 2008 and 2012 **in the non-x86 server space** equalling a four year compound annual growth rate of 16.7%.
- **Linux is Linux**, but ...features, properties and quality differ dependent on your platform

Source: <http://www.baselinemag.com/c/a/Intelligence/40-Fast-Facts-on-Linux-727574/>  
<http://www.internetnews.com/dev-news/article.php/3659961>  
[http://public.dhe.ibm.com/software/au/downloads/IBM\\_zLinux\\_DAG\\_FINAL.pdf](http://public.dhe.ibm.com/software/au/downloads/IBM_zLinux_DAG_FINAL.pdf)  
<http://www.h-online.com/open/news/item/Study-Linux-kernel-R-D-worth-over-1-billion-euros-940817.html>

# Linux kernel development: rate of change

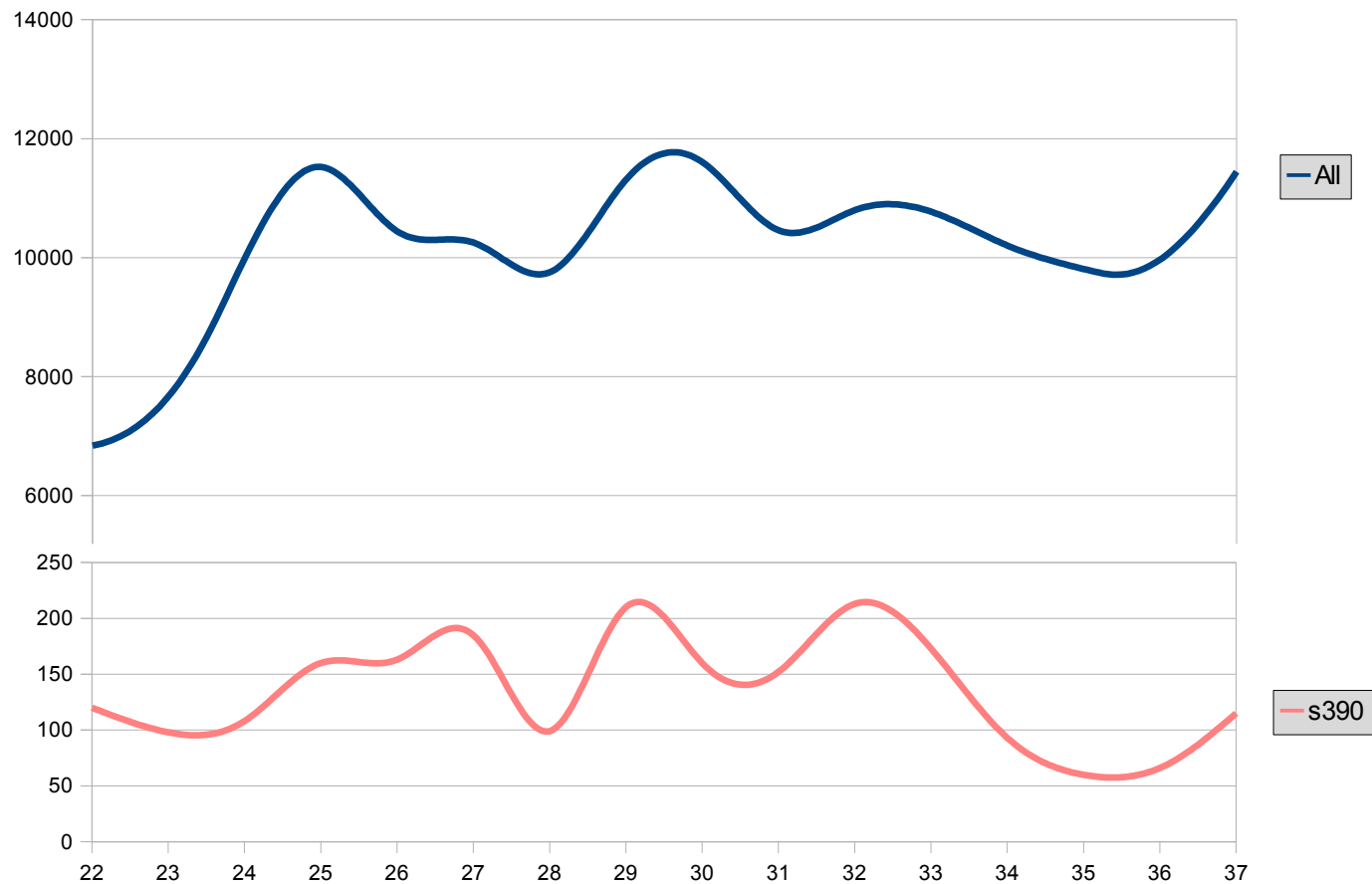
Average: 6683 lines added, 3774 lines removed, 1797 lines changed every day for the last 5 1/2 years.



Source: [http://www.linuxfoundation.org/docs/lf\\_linux\\_kernel\\_development\\_2010.pdf](http://www.linuxfoundation.org/docs/lf_linux_kernel_development_2010.pdf)

# Linux kernel development: System z contributions

- Changesets per 2.6.x kernel release



## 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 3 (GA 09/2009)
- SUSE Linux Enterprise Server 11 (GA 03/2009)
  - Kernel 2.6.27, GCC 4.3.3, Service Pack 1 (GA 06/2010), Kernel 2.6.32
- 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 6 (GA 01/2011)
- **Red Hat Enterprise Linux AS 6 (GA 11/2010)**
  - Kernel 2.6.32, GCC 4.4.0
- Others
  - Debian, Slackware,
  - Support may be available by some third party



# Supported Linux Distributions

Distribution	zEnterprise 196	System z10	System z9	zSeries
RHEL 6	✓	✓	✓	X
RHEL 5	✓	✓	✓	✓
RHEL 4 (*)	✓ (1)	✓	✓	✓
SLES 11	✓	✓	✓	X
SLES 10	✓	✓	✓	✓
SLES 9 (*)	✓ (2)	✓	✓	✓

✓ Indicates that the distribution (version) has been tested by IBM on the hardware platform, will run on the system, and is an IBM supported environment. Updates or service packs applied to the distribution are also supported.

(1) RHEL 4.8 only. Some functions have changed or are not available with the z196, e.g. the Dual-port OSA cards support to name one of several. Please check with your service provider regarding the end of service.

(2) SLES 9 SP4 + latest maintenance updates only. Some functions have changed or are not available with the z196, e.g. the Dual-port OSA cards support to name one of several. Please check with your service provider regarding the end of service.

X Indicates that the distribution is not supported by IBM.

(\*) Also available as 31-bit distribution.

## Kernel news – Common code

### **Linux version 2.6.33 (2010-02-24)**

- DRDB (Distributed Replicated Block Device)
- TCP Cookie Transactions for DNSSEC protocol
- Swappable KSM pages
- Compcache: memory compressed swapping

### **Linux version 2.6.34 (2010-05-16)**

- Ceph distributed network file system
- LogFS flash memory file system
- Asynchronous suspend / resume
- 'Perf' performance analysis improvements, cross architecture support

## Kernel news – Common code

### **Linux version 2.6.35 (2010-08-01)**

- Filesystems: btrfs improvements, XFS delayed logging
- Support for multiple multicast route tables
- Support for Layer 2 Tunneling Protocol L2TP Version 3
- Memory compaction

### **Linux version 2.6.36 (2010-10-20)**

- Tiler architecture support
- Concurrency-managed workqueues
- Improve VM-related desktop responsiveness
- Integration of AppArmor
- New out-of-memory killer (OOM)

## Kernel news – Common code

### **Linux version 2.6.37 (2011-01-04)**

- Filesystems: better SMP scalability for ext4, XFS scalability improvements
- Removal of the BKL: Big Kernel Lock
- I/O throttling support for process groups
- Jump labels: performance optimization for disabled tracepoints

### **Linux version 2.6.38-rc4 (2011-02-07)**

- Automatic process grouping (SCHED\_AUTOGROUP)
- RCU-based path name lookup (dcache scalability)
- Transparent huge pages
- Transmit packet steering (XPS) for multiqueue devices

## System z kernel features – Core

- Improved QDIO performance statistics (kernel 2.6.33)
  - Converts global statistics to per-device statistics and adds new counter for the input queue fill condition.
- Breaking event address for user space programs (kernel 2.6.35)
  - Store the breaking-event-address for user space programs
  - Valuable aid in the analysis of wild branches
- z196 enhanced node affinity support (kernel 2.6.37)
  - Allows the Linux scheduler to optimize its decisions based on the z196 topology.
- Performance indicator bytes (kernel 2.6.37)
  - Display capacity adjustment indicator introduced with z196 via /proc/sysinfo.
- QDIO outbound scan algorithm (kernel 2.6.38)
  - Improved scheduling of QDIO tasklets, OSA / HiperSockets / zfcps need different thresholds.
- Precise process accounting (> kernel 2.6.38)
  - Extend the taskstats interface to provide better process accounting values
  - Quality goal is a resolution of 10ths of microseconds in a snapshot over all tasks

## System z kernel features – z/VM

- Deliver z/VM CP special messages as uevent (kernel 2.6.34)
  - Allows to forward SMSG messages starting with “APP” to user space.
  - udev rules can be used to trigger application specific actions
- Automatic detection of read-only devices (2.6.34)
  - Improve usability by automatically detection of read-only dasd devices with diagnose 210
- CMSFS user space file system support (s390-tools 1.9.0 for the read-only cmsfs support)
  - Implement a FUSE file system that allows to read from and write to CMSFS minidisks.
  - Writing is difficult, the record based CMSFS does not fit well into the byte stream oriented Linux VFS
- CMSFS configurable code page conversion (s390-tools 1.12.0)
  - Adds a configuration file to CMSFS that defines which CMS files are automatically converted from EBCDIC to ASCII.

## CMSFS user space file system support

- Allows to mount a z/VM minidisk to a Linux mount point
- z/VM minidisk needs to be in the enhanced disk format (EDF)
- The cmsfs fuse file system transparently integrates the files on the minidisk into the Linux VFS, no special command required

```
# cmsfs-fuse /dev/dasde /mnt/cms
# ls -la /mnt/fuse/PROFILE.EXEC
-r--r----- 1 root root 3360 Jun 26 2009 /mnt/fuse/PROFILE.EXEC
```

- By default no conversion is performed
  - Mount with '-t' to get automatic EBCDIC to ASCII conversion

```
# cmsfs-fuse -t /dev/dasde /mnt/cms
```

- Write support is work in progress, almost completed
  - use “vi” to edit PROFILE.EXEC anyone ?
- Use fusermount to unmount the file system again

```
# fusermount -u /mnt/cms
```

## System z kernel features – Storage FICON

- Resume reordered devices (kernel 2.6.34)
  - Allow resume of a guest with different subchannels for individual devices
  - Allow suspend of a system with devices in the disconnected state
- Unit check handling (kernel 2.6.35)
  - Improve handling of unit checks for internal I/O started by the common-I/O layer
  - After a unit check certain setup steps need to be repeated, e.g. for PAV
- Store I/O status and initiate logging (SIOSL) (kernel 2.6.36)
  - Enhance debug capability for FCP attached devices
  - Enables operating system to detect unusual conditions on a device of channel path
- Tunable default grace period for missing interrupts in DASD (kernel 2.6.36)
  - Provide a user interface to specify the timeout for missings interrupts for standard I/O operations on DASD



# System z kernel features – Storage FICON

- **Dynamic PAV toleration (kernel 2.6.35)**
  - Tolerate dynamic Parallel Access Volume changes for base PAV
  - System management tools can reassign PAV alias device to different base devices.
- **CHPID reconfiguration handling (kernel 2.6.37)**
  - Update data structures after channel-path related information change
  - Inform device drivers about relevant changes
- **Query DASD reservation status (kernel 2.6.37)**
  - New DASd ioctl to read the 'Sense Path Group ID' data
  - Allows to determine the reservation status of a DASD in relation to the current Linux
- **Multi-track extension for HPF (kernel 2.6.38)**
  - Allows to read from and write to multiple tracks with a single CCW
- **Improve handling of stolen DASD reservation (kernel 2.6.38)**
  - Provide alternatives to handle unit checks that indicate stolen reservations
    - Fail any request to a device until it is set offline
    - Queue I/O until reservation is release again

## System z kernel features – Storage FICON

- Access to raw ECKD data from Linux (kernel 2.6.38)
  - This item allows to access ECKD disks in raw mode
  - Use the 'dd' command to copy the disk level content of an ECKD disk to a Linux file, and vice versa.
  - Storage array needs to support read-track and write-full-track command.
- Automatic menu support in zipl (s390-tools 1.11.0)
  - Zipl option that will create a boot menu for all eligible non-menu sections in the zipl configuration file
- reIPL from device-mapper devices (s390-tools 1.12.0)
  - The automatic re-IPL function only works with a physical device
  - Enhance the zipl support for device-mapper devices to provide the name of the physical device if the zipl target is located on a logical device

## System z kernel features – Storage FCP

- End-to-end data consistency checking (kernel 2.6.36, experimental)
  - Use checksum of SCSI data payload to check end-to-end consistency
  - Needs common code changes to file systems
- SAN utilities (trace, ping, ..) (kernel 2.6.36, lib-zfcp-hbaapi 2.1)
  - Two new utilities have been added: zfcp\_ping and zfcp\_show
  - They are useful to discover a storage area network
- Automatic LUN scanning (kernel 2.6.37)
  - Scan and attach accessible LUNs automatically
  - Available only for a NPIV FCP attachment
- SCSI device management tool (> s390-tools 1.12.0)
  - Implement a tool analog chccwdev which allows to enable/disable a SCSI LUN addressed by HBA/target port/LUN.

## System z kernel features – Networking

- OSA QDIO Data Connection Isolation (kernel 2.6.33)
  - Isolate data traffic from Linux on System z guests sharing an OSA card
  - Communication between guests needs to go over via external entity
- HiperSockets Network Traffic Analyser (kernel 2.6.34)
  - Trace HiperSockets network traffic for problem isolation and resolution.
  - Supported for layer 2 and layer 3
- Offload outbound checksumming (kernel 2.6.35)
  - Move calculation of checksum for non-TSO packets from the driver to the OSA network card
- Toleration of optimized latency mode (kernel 2.6.35)
  - OSA devices in optimized latency mode can only serve a small number of stacks / users. Print a helpful error message if the user limit is reached.
  - Linux does not exploit the optimized latency mode

## System z kernel features – Networking

- OSX (OSM) CHPIDs for hybrid data network (kernel 2.6.35)
  - The OSA cards for the zBX Blade Center Extension will have a new CHPID type
  - Allows communication between zBX and Linux on System z
- NAPI support for QDIO and QETH (kernel 2.6.36)
  - Convert QETH to the NAPI interface, the “new” Linux networking API
  - NAPI allows for transparent GRO (generic receive offload)
- QETH debugging per single card (kernel 2.6.36)
  - Split some of the global QETH debug areas into separate per-device areas
  - Simplifies debugging for complex multi-homed configurations

## System z kernel features – Networking

- Support for assisted VLAN null tagging (kernel 2.6.37)
  - Close a gap between OSA and Linux to process null tagged frames correctly
  - z/OS may sent null-tagged frames to Linux
- IPv6 support for the qetharp tool (kernel 2.6.38)
  - Extend the qetharp tool to provide IPv6 information in case of a layer 3 setup.
  - This is required for communication with z/OS via HiperSockets using IPv6.
- Configuration tool for System z network devices (s390-tools 1.8.4)
  - Provide a shell script to ease configuration of System z network devices

## znetconf network device configuration tool

- Allows to list, add, remove & configure System z network devices
- For example: list all potential network devices:

```
# znetconf -u
Device Ids                Type      Card Type  CHPID  Drv.
-----
0.0.f500,0.0.f501,0.0.f502 1731/01  OSA (QDIO)  00     qeth
0.0.f503,0.0.f504,0.0.f505 1731/01  OSA (QDIO)  01     qeth
```

- Configure device 0.0.f503

```
znetconf -a 0.0.f503
```

- Configure device 0.0.f503 in layer2 mode and portname “myport”

```
znetconf -a 0.0.f503 -o layer2=1 -o portname=myport
```

- Remove network device 0.0.f503

```
znetconf -r 0.0.f503
```

## System z kernel features – Usability / RAS

- Dump on panic – prevent reipl loop (s390-tools 1.8.4)
  - Delay arming of automatic reipl after dump
  - Avoids dump loops where the restarted system crashes immediately
- Add support for makedumpfile tool (kernel 2.6.34, s390-tools 1.9.0)
  - Convert Linux dumps to the ELF file format
  - Use the makedumpfile tool to remove user data from the dump
  - Multi-volume tape dump will be removed
- Kernel image compression (kernel 2.6.34)
  - The kernel image size can be reduced by using one of three compression algorithms: gzip, bzip2 or lzma.
- Tool to trigger SCSI dump on remove container (snipl 2.1.9)



## System z kernel features – Security

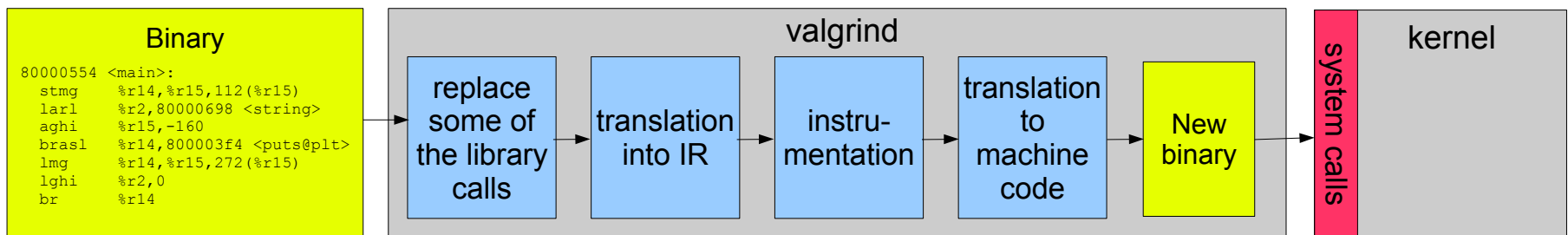
- Crypto Express 3 (kernel 2.6.33)
  - Toleration support for Crypto Express 3 in Accelerator and Coprocessor mode
- 4096 bit RSA fast path (kernel 2.6.38)
  - Make use of 4096 bit RSA acceleration available with Crypto Express 3 GA2 cards.
- Address space randomization (kernel 2.6.38)
  - Enable flexible mmap layout for 64 bit
  - Randomize start address for the runtime stack and the mmap area
- New libica APIs for supported crypto modes
  - Provide a programmatic way to query for supported crypto ciphers, modes and key sizes.
  - Deliver information wheter the cryptographic features are implemented in hardware or in software

# System z toolchain

- zEnterprise 196 exploitation (gcc 4.6)
  - Use option `-march=z196` to utilize the new instructions added with z196
  - Use `-mtune=z196` to schedule the instruction appropriate for the new out-of-order pipeline of z196
- 64 bit register in 31 bit compat mode
  - Make use of 64 bit registers in 31 bit application running in z/Architecture mode.
  - Allows to use instruction operating on 64 bits, e.g. 64 bit multiplication
  - Needs kernel support for asynchronous signals
- Oprofile hardware customer mode sampling
  - Provide CPU measurement data to applications for performance tuning
  - Based on hardware counters and samples built into the CPU
  - Use oprofile to communicate the information to user space programs
- Valgrind System z support
  - Valgrind is a generic framework for creating dynamic analysis tools and can be used for memory debugging, memory leak detection and profiling (e.g. cachegrind)
  - Valgrind is in essence a virtual machine using just-in-time (JIT) compilation techniques

## Valgrind System z support

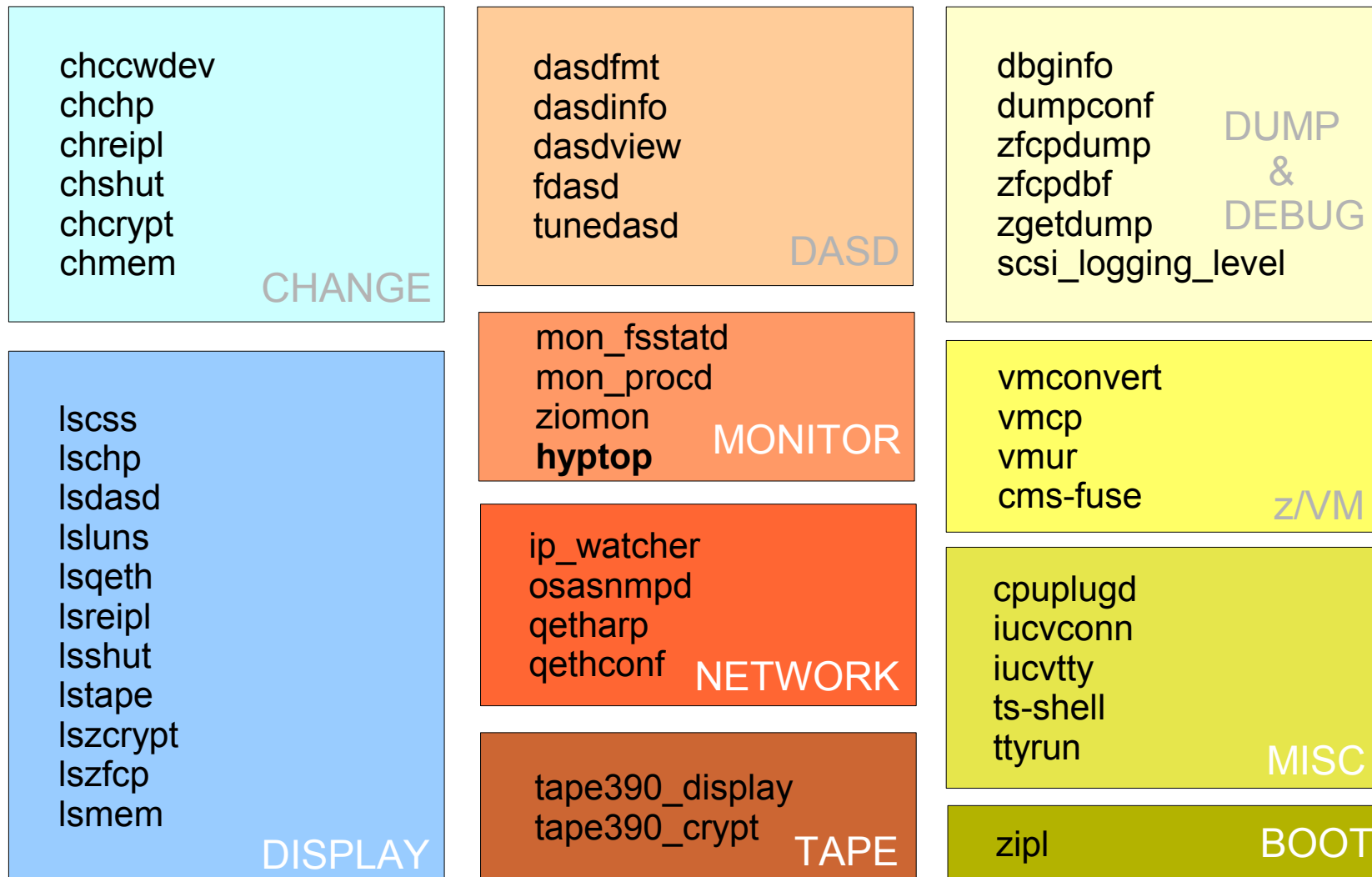
- `valgrind --tool=memcheck [--leak-check=full] [--track-origins] <program>`
  - Detects if your program accesses memory it shouldn't
  - Detects dangerous uses of uninitialized values on a per-bit basis
  - Detects leaked memory, double frees and mismatched frees
- `valgrind --tool=cachegrind`
  - Profile cache usage, simulates instruction and data cache of the cpu
  - Identifies the number of cache misses
- `valgrind --tool=massif`
  - Profile heap usage, takes regular snapshots of program's heap
  - Produces a graph showing heap usage over time



## s390-tools package: what is it?

- s390-tools is a package with a set of user space utilities to be used with the Linux on System z distributions.
  - It is **the** essential tool chain for Linux on System z
  - It contains everything from the boot loader to dump related tools for a system crash analysis .
- This software package is contained in all major (and IBM supported) enterprise Linux distributions which support s390
  - RedHat Enterprise Linux 4
  - RedHat Enterprise Linux 5
  - RedHat Enterprise Linux 6
  - SuSE Linux Enterprise Server 9
  - SuSE Linux Enterprise Server 10
  - SuSE Linux Enterprise Server 11
- Website:  
<http://www.ibm.com/developerworks/linux/linux390/s390-tools.html>
- Feedback: [linux390@de.ibm.com](mailto:linux390@de.ibm.com)

# s390-tools package: the content



## s390-tools package

- Version 1.8.4 (2010-03-12)
  - readahead: udev rule to increase default maximum readahead
  - networking: znetconf configuration script
  - dump on panic: prevent reipl loop
  - zipl: calculate boot device ramdisk address
- Version 1.9.0 (2010-05-28)
  - cmsfs-fuse: User space filesystem to access z/VM CMS disks
  - lsmem/chmem: scripts to display / change memory setup
  - ttyrun: tool to safely start getty
  - chccwdev, cio\_ignore: Use /proc/cio\_settle
  - lsqeth: Add new attribute “sniffer” for HiperSockets Network Traffic Analyzer
  - zgetdump: Add dump conversion and mount support, zgetdump can now be used to convert a System z dump to ELF
  - tape: dropped support for multi-volume tape dumps

## s390-tools package

- Version 1.10.0 (2010-09-16)
  - chchp: Use /proc/cio\_settle
  - znetconf: Add support for new CHPIDs OSX and OSM
- Version 1.11.0 (2010-10-22)
  - cmsfs-fuse: Add write support
  - zipl: Add support for automatic menus
- Version 1.12.0 (2011-01-27)
  - **hyptop: Provides real-time view of System z hypervisor environment**
  - chreipl: Various enhancements
  - cio\_ignore: Add query option
  - cmsfs-fuse: Configurable code page conversion
  - tunedasd: Add option to query reservation status of a device
  - zgetdump: Add kdump support for –info option
  - zfcpdump/zipl: Disable automatic activation of LUNs

## hyptop: Display hypervisor utilization data

- The hyptop command is a top-like tool that displays a dynamic real-time view of the hypervisor environment
  - hyptop works with z/VM and the LPAR hypervisor
  - The debugfs file system must be mounted
  - To monitor all LPARs or z/VM guests your instance requires additional privileges
    - For z/VM: The user ID requires privilege class B
    - For LPAR: The global performance data control box in the LPAR activation profile needs to be selected
- Example of single LPAR utilization data

```
10:16:59 H05LP30 CPU-T: IFL(18) CP(3) UN(2)                                     ?=help
cpuid  type      cpu  mgm  visual
(##)   (str)      (%) (%)  (vis)
0_____ IFL  29.34 0.72 |#####
1_____ IFL  28.17 0.70 |#####
2_____ IFL  32.86 0.74 |#####
3_____ IFL  31.29 0.75 |#####
4_____ IFL  32.86 0.72 |#####
5_____ IFL  30.94 0.68 |#####
6_____ IFL   0.00 0.00 |
7_____ IFL   0.00 0.00 |
8_____ IFL   0.00 0.00 |
9_____ IFL   0.00 0.00 |
=:V:N          185.46 4.30
```



# hyptop: Display hypervisor utilization data

- Example of z/VM utilization data

```
10:11:56 CPU-T: UN(16) ?=help
```

system (str)	#cpu (#)	cpu (%)	Cpu+ (hm)	online (dhm)	memuse (GiB)	memmax (GiB)	wcur (#)
T6360003	6	<u>506.92</u>	3404:17	44:20:53	7.99	8.00	100
T6360017	2	<u>199.58</u>	8:37	29:23:50	0.75	0.75	100
T6360004	6	<u>99.84</u>	989:37	62:00:00	1.33	2.00	100
T6360005	2	<u>0.77</u>	0:16	5:23:06	0.55	2.00	100
T6360015	4	<u>0.15</u>	9:42	18:23:04	0.34	0.75	100
T6360035	2	<u>0.11</u>	0:26	7:18:15	0.77	1.00	100
T6360027	2	<u>0.07</u>	2:53	62:21:46	0.75	0.75	100
T6360049	2	<u>0.06</u>	1:27	61:17:35	0.65	1.00	100
T6360010	6	<u>0.06</u>	5:55	61:20:56	0.83	1.00	100
T6360021	2	<u>0.06</u>	1:04	48:19:08	0.34	4.00	100
T6360048	2	<u>0.04</u>	0:27	49:00:51	0.29	1.00	100
T6360016	2	<u>0.04</u>	6:09	34:19:37	0.30	0.75	100
T6360008	2	<u>0.04</u>	3:49	47:23:10	0.35	0.75	100
T6360006	2	<u>0.03</u>	0:57	25:20:37	0.54	1.00	100
NSLCF1	1	<u>0.01</u>	0:02	62:21:46	0.03	0.25	100
VTAM	1	<u>0.00</u>	0:01	62:21:46	0.01	0.03	100
T6360023	2	<u>0.00</u>	0:04	6:21:20	0.46	0.75	100
PERFSVM	1	<u>0.00</u>	2:12	7:18:04	0.05	0.06	0
AUTOVM	1	<u>0.00</u>	0:03	62:21:46	0.00	0.03	100
FTPSERVE	1	<u>0.00</u>	0:00	62:21:47	0.01	0.03	100
TCPIP	1	<u>0.00</u>	0:01	62:21:47	0.01	0.12	3000
DATAMOVE	1	<u>0.00</u>	0:06	62:21:47	0.00	0.03	100
VMSEVRU	1	<u>0.00</u>	0:00	62:21:47	0.00	0.03	1500
OPERSVMP	1	<u>0.00</u>	0:00	62:21:47	0.00	0.03	100

# More information

IBM developerWorks : Linux : Linux on System z : Development stream : s390-tools - Iceweasel <2>

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http://www.ibm.com/developerworks/linux/linux390/s390-tools.html

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## Using the Dump Tools

### November, 2008

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## Device Drivers, Features, and Commands

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Linux on System z

## How to Set up a Terminal Server Environment on z/VM

### June 2009

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## The IBM zEnterprise System – A new dimension in computing



- **The IBM zEnterprise 196 (z196) was announced 2010-07-22**
- **Naturally it is supported by Linux on System z**
- **The upstream code supports the following new features of the z196:**
  - Third subchannel set
  - Up to 32 HiperSockets
  - Support for the new OSA CHPID types OSX and OSM
  - Toolchain support (gcc, binutils)
  - More features to follow

Get all the important hardware details at:

[http://www.ibm.com/common/ssi/rep\\_ca/0/897/ENUS110-170/ENUS110-170.PDF](http://www.ibm.com/common/ssi/rep_ca/0/897/ENUS110-170/ENUS110-170.PDF)

# Questions?



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Development*

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