

Mainframe Topics

Kapitel 4

Virtualisierung auf dem Mainframe

Linux on IBM z Systems



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Agenda

What is Linux on system z?

Synergies of Linux on system z

What's unique to Linux on IBM System z?

Good fit application workloads

Typical recommended solution on Linux on system z

Applications and Opensource Software

Distributions

Needed skills

In the end...

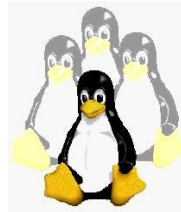
Linux Benefits



What's so special about Linux - what are the advantages of Linux?

Linux is scalable

- Supports multiple hardware platforms
- Spanning from embedded devices to supercomputers
- Speed of support for new platforms
- Availability of skills, portability of applications
- Scale-out through clustering and scale-up through SMP



Linux has an affinity to virtualization

- Supported on all commercial major hypervisors, from z/VM to VMware and Hyper-V
- Also support Open Source hypervisors, like KVM, Xen, Linux Containers and more
- Ability to run full- or para-virtualized
- KVM, Linux Containers (and largely Xen) virtualization build-in to the default Kernel



Linux is Open

- No vendor lock-in
- Developed by an open community
- Broad skill availability
- Based on Open Standards
- Application interoperability
- Sharing skills and resources leads to faster development
- World-wide community leads to collaborative innovation



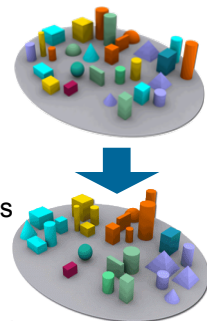
Linux is Reliable and Secure

- Linux is stable and Secure
- Reliability, stability, and security
- Derived from UNIX
- Can be hardly locked-down (even root via SELinux)
- A huge set of crypto functionality included
- Open Source implements the "many eyes" concept
- Upgradeability of the existing platform

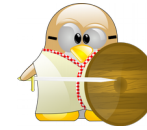


Linux is flexible and efficient

- Lower total cost of life cycle ownership
- Adaptability due to modularization and customizations
- Has flexible usage licensing
- Respond quickly to new or changing business goals
- Poor utilization of server capacity across the board
- Multiple, overlapping application and OS instances



Linux Kernel – One 'tar ball' to rule them all



- The Linux kernel is **highly portable** (even if initially not developed to be) and supports the following computer architectures:
- One **single set of source code** available from “The Linux Kernel Archives”:
<http://kernel.org> – <http://git.kernel.org>
- Linux for different architectures is all **build from the same source!**
- All **architecture dependent code** is included:
 - Linux Kernel Sources:
`/linux/arch/s390`
`/linux/drivers/s390`
 - Linux Kernel Headers (`include/asm`)
- Linux is always an **ASCII** operating system, even Linux on System z, running on the Extended Binary Coded Decimal Interchange Code (EBCDIC) encoded z/Architecture



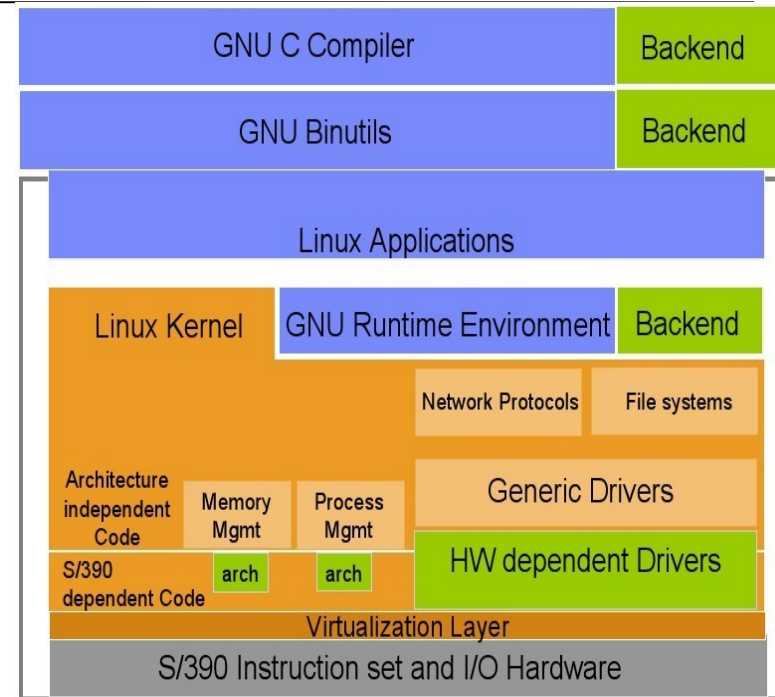
[[linux/kernel/git/torvalds/linux-2.6.git](https://git.kernel.org/torvalds/linux-2.6.git)] / arch /

- Alpha architecture (`alpha`)
- Analog Devices (`blackfin`)
- ARM architecture (`arm`)
- Atmel AVR32 (`avr32`)
- Axis Communications' ETRAX CRIS (`cris`)
- Freescale's (formerly Motorola's) 68k (`m68k`)
- Fujitsu FR-V (`frv`)
- HP PA-RISC (`parisc`)
- H8 Renesas Technology, formerly Hitachi (H8300)
- **IBM System/390 (31-bit), z/Architecture (64-bit) (s390)**
- Intel IA-64 Itanium, Itanium II (`ia64`)
- **x86 architecture: 80386 ... x86_64 (x86)**
- M32R from Mitsubishi (`m32r`)
- Microblaze from Xilinx (`microblaze`)
- MIPS architecture (`mips`)
- MN103 from Panasonic Corporation (`mn10300`)
- OpenRISC (`openrisc`)
- **IBM POWER architecture (powerpc)**
- PowerPC architecture (`powerpc`)
- IBM's Cell (`powerpc`)
- SPARC, UltraSPARC (`sparc`)
- SuperH (`sh`)
- S+core (`score`)
- Tiler (tile)
- Xtensa from Tensilica (`xtensa`)
- UniCore32 (`unicore32`)
- User Mode Linux, UML (`um`)



What is Linux on System z?

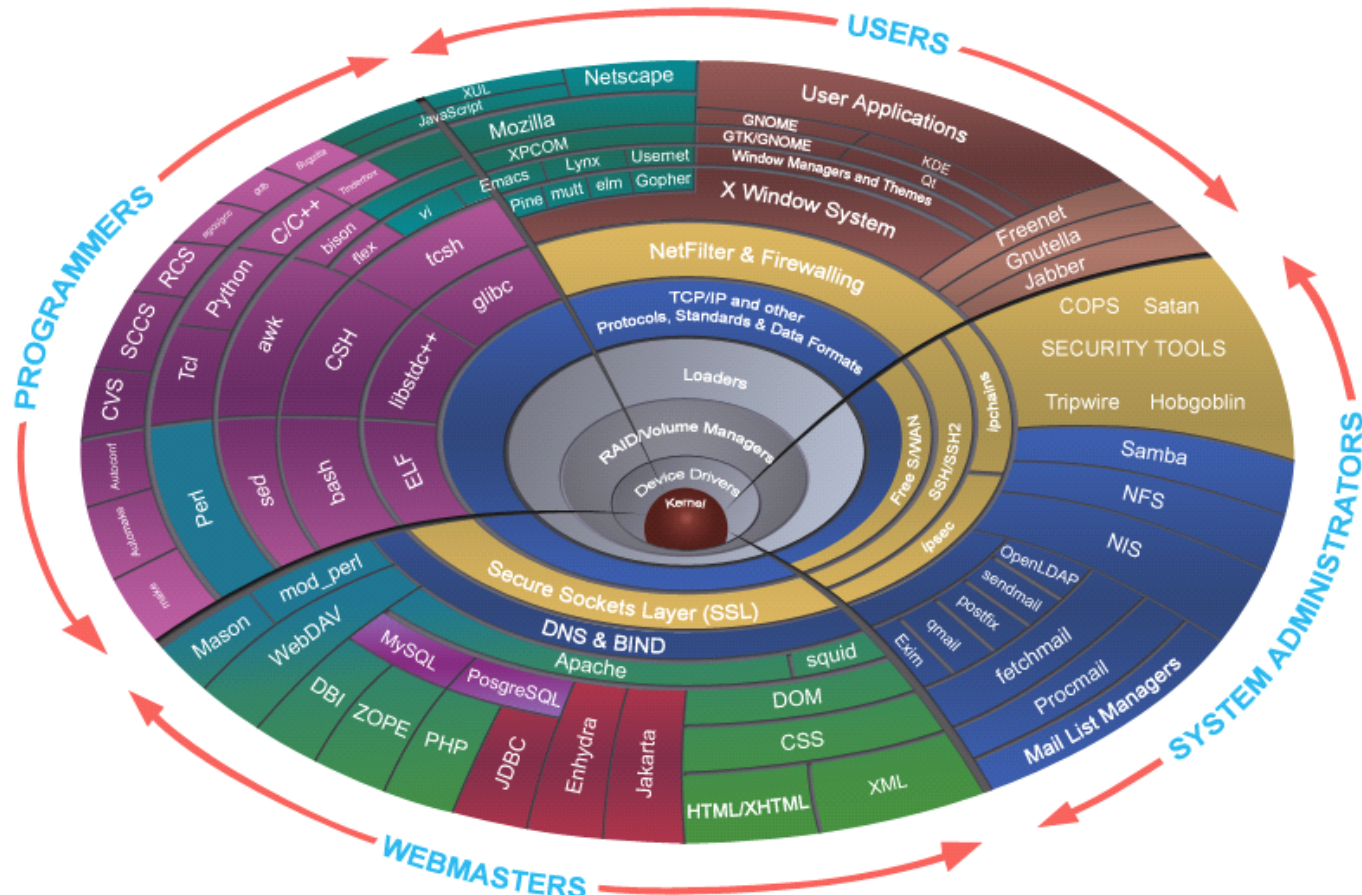
- **Linux for IBM z Systems** refers to Linux running on IBM z13
- **Linux on System z** (or zSeries) refers to Linux on the mainframe in general, until z13
- **Linux for System z** (or zSeries) refers to a 64-bit Linux distribution for Linux on System z (Machines: zEC12, z196, z114, z10 EC, z10 BC, z9 EC, z9 BC, z990, z890, z900, z800 – Linux architecture: s390x)
- **Linux for S/390** refers to a 31-bit distribution for Linux on System z (Machines: 9672, G5, G6, and Multiprise – Linux architecture: s390)
- **Port of the open source** GNU/Linux operating system to the System z architecture
- **Pure Linux** it's an ASCII environment like other Linux too
- Natively exploits IBM System z hardware **no emulation**
- Runs **native**, in an LPAR **or** virtualized **under z/VM**
- Runs on IFLs (Integrated Processors for Linux) or CPs (Central Processors)
- **Design Principles** of Linux on System z:
 - > Not a unique version of Linux (no changes to the standard)
 - > No changes regarding Look & Feel
 - > Not a replacement for an other IBM eServer operating system



Initially the System z related code was less than 1%!

What is a Linux Distribution?

Linux is packaged in a format known as a Linux distribution, e.g. for desktop and server or other use



O'Reilly, Charting the Linux Anatomy by Ed Stephenson, 01/29/2001

http://www.oreillynet.com/pub/a/oreilly/linux/news/linuxanatomy_0101.html



Linux is Linux is ...

... but System z provides unmatched value propositions to Linux workloads

Consolidation Capabilities:

Server, Network, Storage, Staff, Skills, Utilities, Environmental,
Applications Hosting of different workloads at the same time

Security Capabilities:

Privacy,
Regulatory requirements,
Identity management,
Common Criteria Certification,
Ethical hacking by research,
Image Isolation,
Cryptographic Acceleration,
Centralized Authentication,
Physically secure communications
with HiperSockets and Guest LANs

Operational Simplification Capabilities:

Virtualization,
Simulation,
Single Point of Control,
Single System Image,
z/OS Similarities/Synergies,
Resource Sharing

Proximity to z/OS managed Data:

Increased transaction throughput,
HiperSockets
Shared data access
Integrated storage management

Business Resiliency Capabilities:

High Availability,
Disaster Recovery,
Serviceability, Reliability,
Storage failover (HyperSwap),
Data replication (XRC, PPRC),
Concurrent Processor
Reassignment

Flexibility / On demand Capabilities:

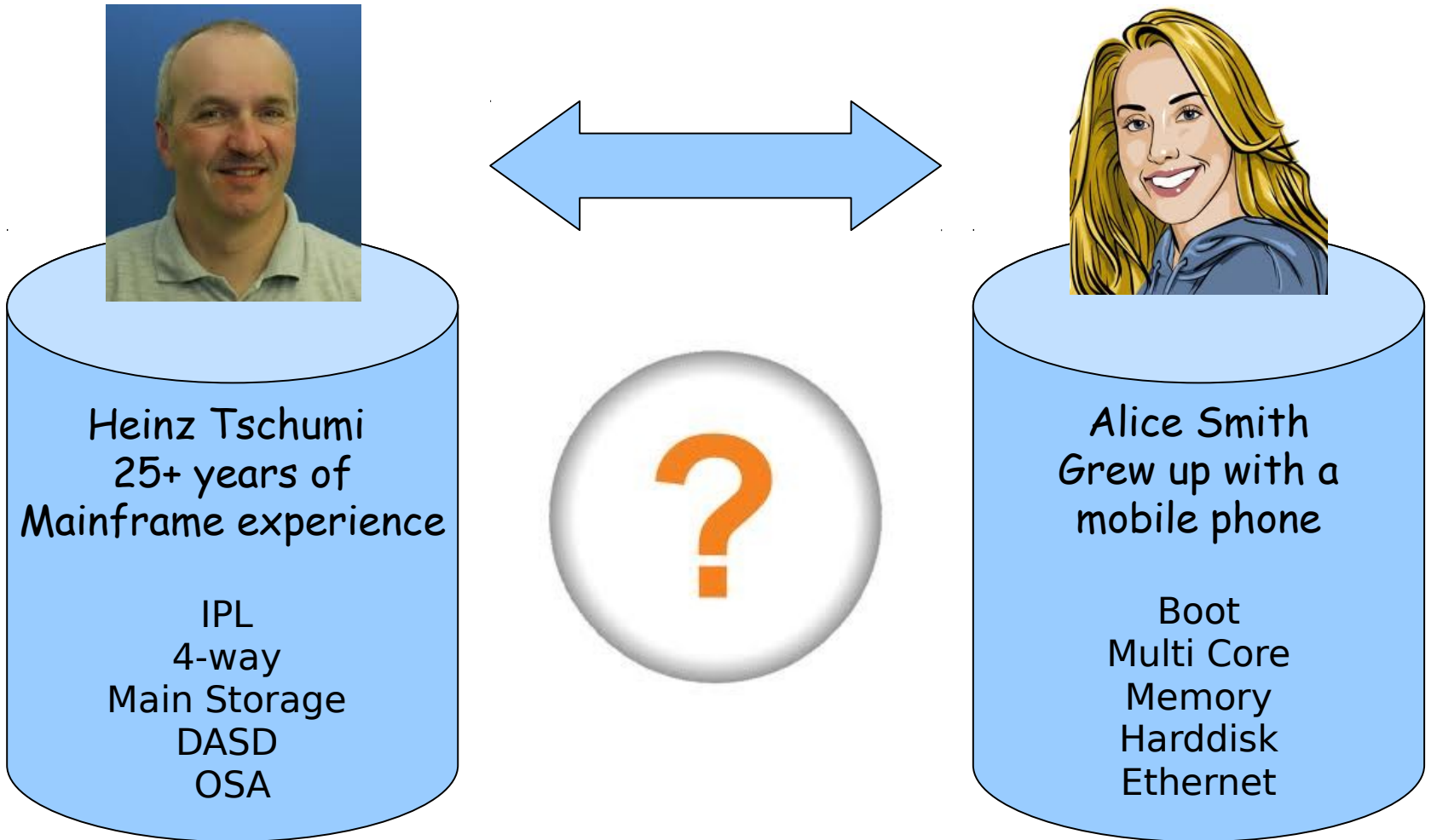
Scale-up & scale-out,
Rapid server
(de-)commissioning,
Idle Servers don't
consume resources

**System z,
Linux and
Virtualization**

How to discover that you are logged into a Linux System on a different Hardware Architecture?

```
zlx11047:~ # cat /proc/cpuinfo
vendor_id      : IBM/S390
# processors    : 2
bogomips per cpu: 11061.00
features       : esan3 zarch stfle msa ldisp eimm dfp etf3eh highgprs
processor 0: version = FF,  identification = 05B440,  machine = 2097
processor 1: version = FF,  identification = 05B440,  machine = 2097
zlx11047:~ #
zlx11047:~ # uname -a
Linux zlx11047 2.6.32.12-0.7-default #1 SMP Tue May 20 11:14:20 UTC
2010 s390x s390x s390x GNU/Linux
Zlx11047:~ #
zlx11047:~ # cat /proc/version
Linux version 2.6.32.12-0.7-default (geeko@buildhost) (gcc version
4.3.4 [gcc-4_3-branch revision 152973] (SUSE Linux) ) #1 SMP 2010-05-
20 11:14:20 +0200
zlx11047:~ #
zlx11047:~ # cat /proc/service_levels
VM: z/VM Version 6 Release 2.0, service level 1101 (64-bit)
qeth: 0.0.fc00 firmware level V620
zlx11047:~ #
```

Do we all speak the same language?

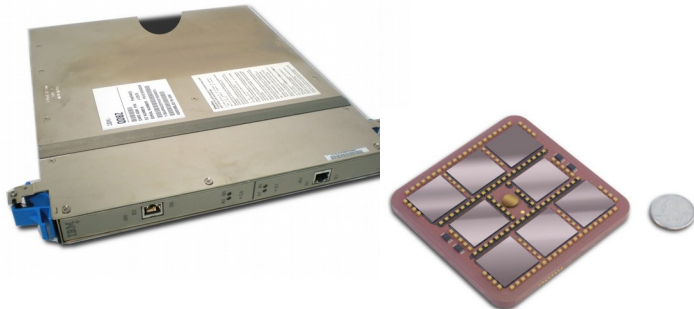


Hardware Comparison – Mainframe vs. Distributed

Mainframe vs. Distributed Terminology

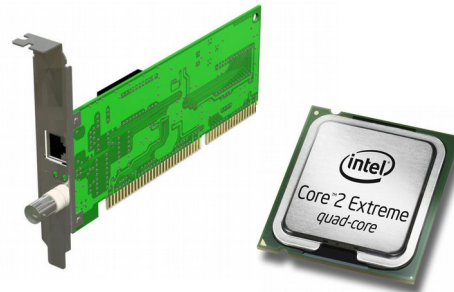
Mainframe

- System programmer
- POR / IML
- IPL
- 4-way
- Main storage
- DASD ← 'external' disk storage
- Dispatcher
- OSA
- CP / IFL ← *Specialty Engines*

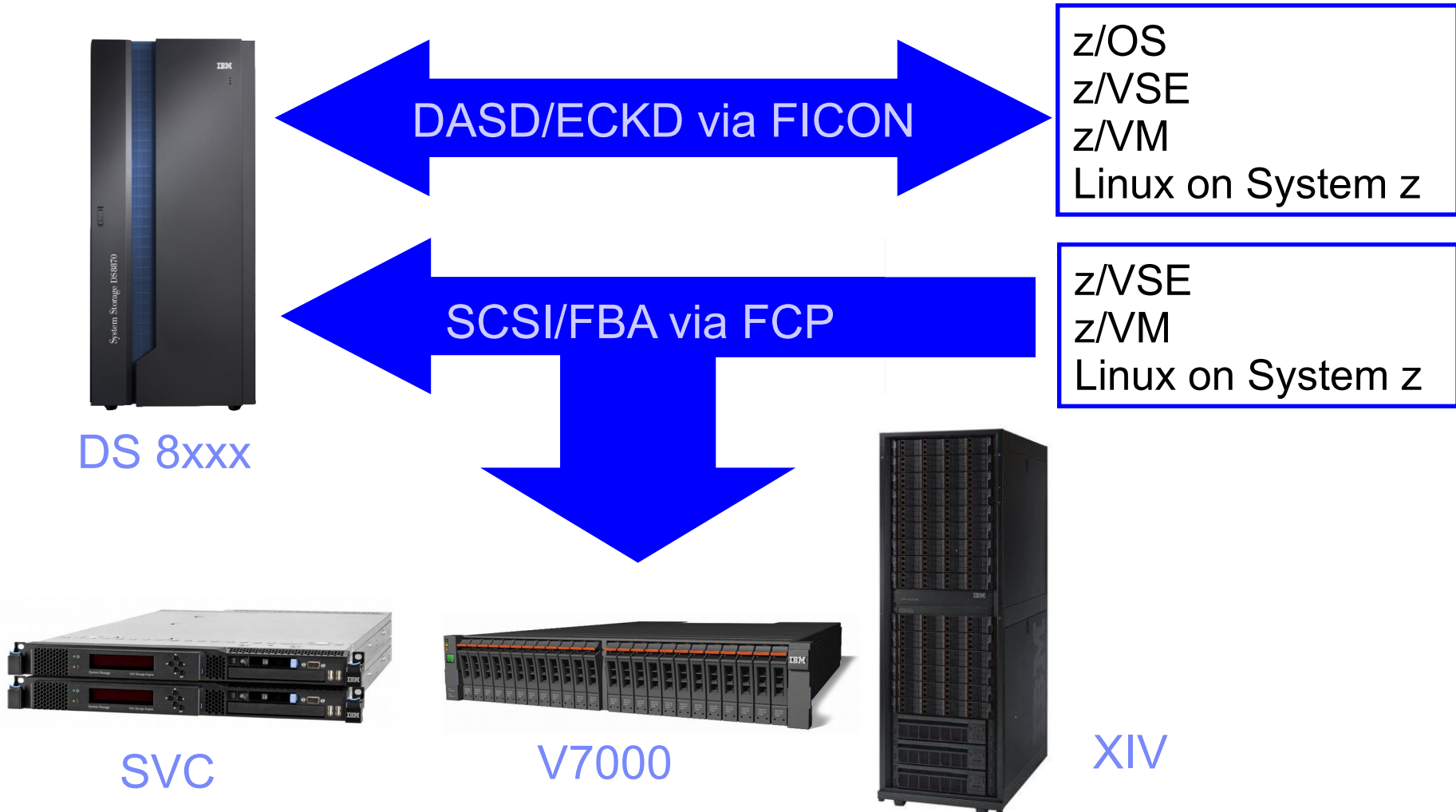


Distributed

- System administrator
- Kaltstart / Boot
- Warmstart / (Re-)Boot
- 4-processor machine
- Main memory
- Disk
- Scheduler
- NIC
- CPU



Mainframe Storage Attachment Options



System Characteristics – Best Fit

1. Business Resiliency: End to End Data Integrity, unmatched MTBF (zero down-time), 100% concurrent maintenance, Parallel Sysplex and Coupling

2. Data intensive, mixed workloads :
large shared caches & large I/O gear,
compression hardware

3. Data Sharing: shared everything via
shared DB2 database across Parallel Sysplex

4. Virtualization & Security: zVM Hypervisor with
1000s of VMs, LPAR with EAL-5 security,
integrated cryptographic hardware

5. Architectural compatibility:
e.g., allows to run applications from
decades ago, unchanged

6. Single Thread Performance:
e.g. CPU bound workloads

7. IO Latency: e.g., high rate interactive,
small messages, etc.

**Better on other
platforms**

**Optimal for
System z**

More than 1400 new and upgraded applications added for z/OS and Linux



- **z/OS**
 - Over 1,080 New or Upgraded applications for z/OS
 - More than 4,400 total z/OS applications
- **Linux**
 - Over 400 New or Upgraded applications for Linux
 - More than 3,000 total Linux applications



TEMENOS
The Banking Software Company



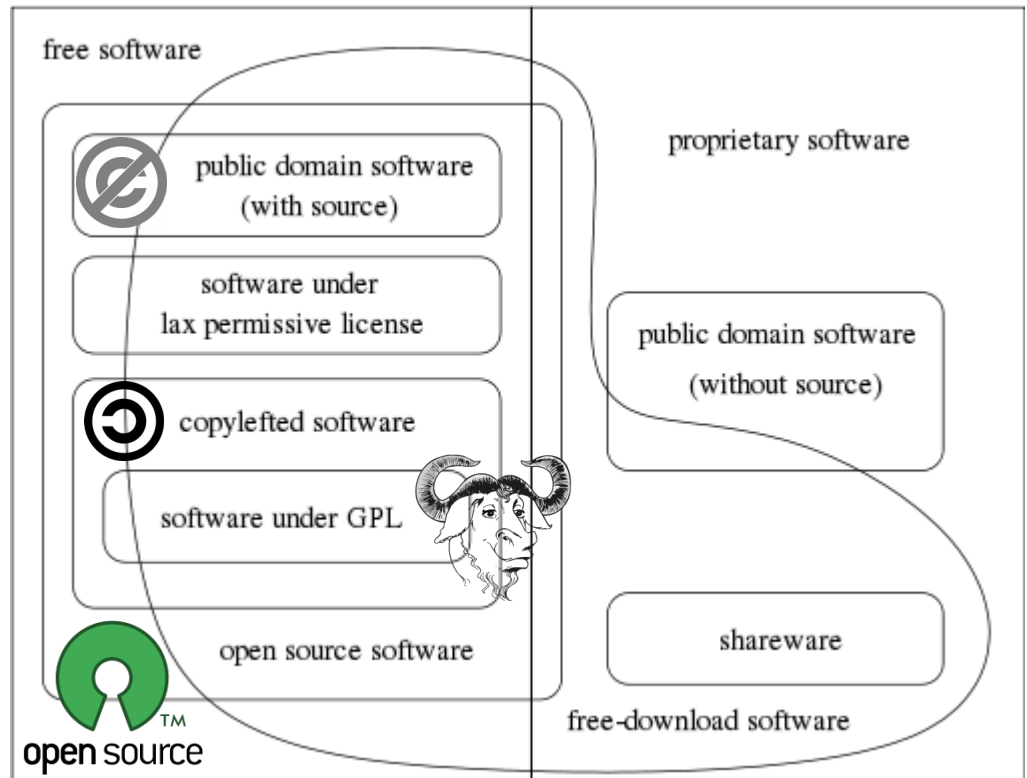
Infosys®



Free software?

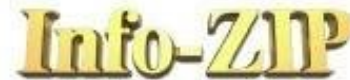
Free software is software that comes with permission for anyone to use, copy, and/or distribute, either verbatim or with modifications, either gratis or for a fee. In particular, this means that source code must be available.

„Nearly all free software is open source, and nearly all open source software is free.“



Source: <http://www.gnu.org/philosophy/categories.html>

Open Source for the Mainframe except Linux



Open Source Software for z/OS and OS/390 UNIX

<http://www.redbooks.ibm.com/redbooks/SG245944.html>



OS/390 and z/OS Freeware (by Lionel B. Dyck)

<http://www.lbdsoftware.com/>



UNIX, Ported and Performance Tools

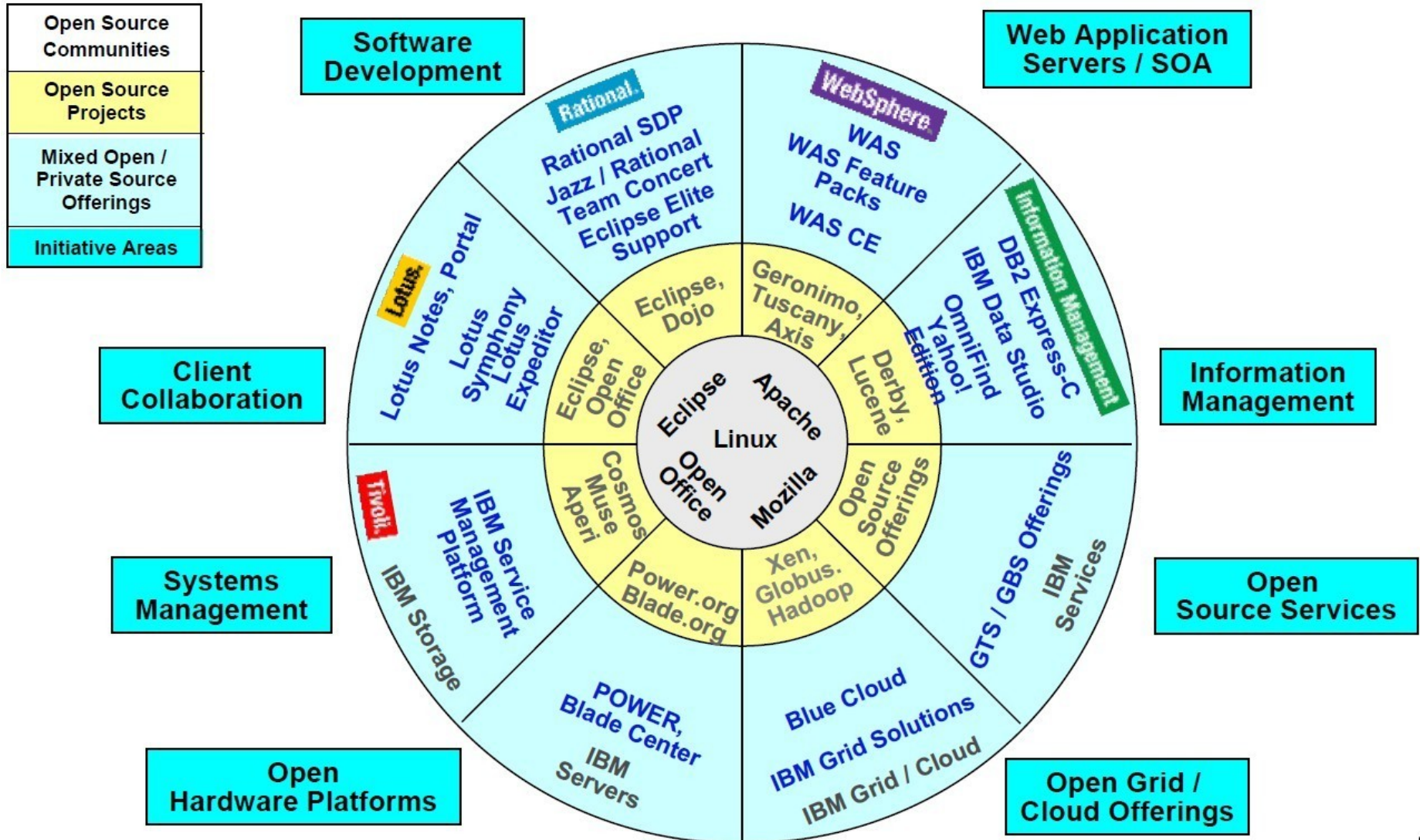
Tools and toys



<http://www-03.ibm.com/systems/z/os/zos/features/unix/tools/>



Open Source, Open Standard and IBM Middleware - Overview



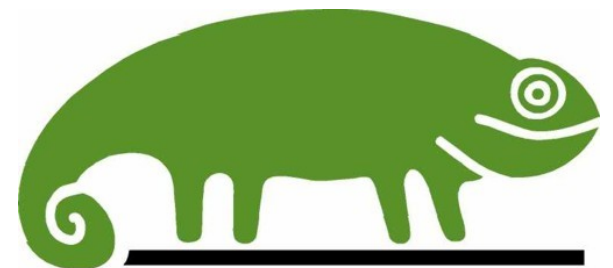
Which distribution?



redhat®



Ubuntu Server



SuSE

Enterprise Linux Distributions – Tested & Supported

The table below shows IBM tested Linux environments. IBM remote technical support for these environments is provided when you obtain a Support Line contract.

You may also find support for these environments by contracting with a third party provider.

Distribution	LinuxONE Emperor	LinuxONE Rockhopper			
	z13	z13s	zEnterprise - zBC12 and zEC12	zEnterprise - z114 and z196	System z10 and System z9
RHEL 7	✓ (1)	✓ (1)	✓ (3)	✓ (3)	✗
RHEL 6	✓ (1)	✓ (1)	✓ (4)	✓	✓
RHEL 5	✓ (1)	✗ (10)	✓ (5)	✓	✓
RHEL 4 (*)	✗	✗	✗	✓ (8)	✓
SLES 12	✓ (2)	✓ (2)	✓	✓	✗
SLES 11	✓ (2)	✓ (2)	✓ (6)	✓	✓
SLES 10 (*)	✗	✗	✓ (7)	✓	✓
SLES 9 (*)	✗	✗	✗	✓ (9)	✓
Ubuntu 16.04	✓	✓	✓	✗	✗

<http://www.ibm.com/systems/z/os/linux/resources/testedplatforms.html>

History of Enterprise Linux

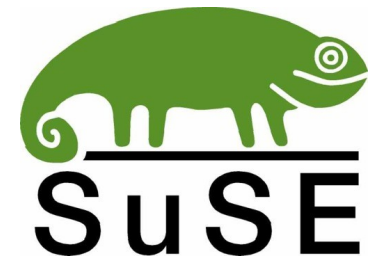


Deciding on a Distribution: Some Advice

- If you are already familiar with one distribution on x86 you might want to run the same flavor on the mainframe.
- If you plan to host an ISV application make sure that it is certified for the distribution of your choice (not all products are certified for each distro).
- Also check the release level (e.g. RHEL 7.1, SLES 12.1, Ubuntu 16.04).
- If you are still unsure, invite a representative of each distribution to your side.

Methodology for Installing and Maintaing Linux

- Manual installation – nobody wants to install 20 servers manually, no matter if they run on x86 or the mainframe!
- Autoyast (SuSE)
- Kickstart (Red Hat)
- Preseed (Ubuntu)
- **Cloning**



The „Why“ and „What“ of Cloning

Why Cloning?

- Standardized configurations
- Facilitates maintenance testing & rollout
- Time savings
- Cost savings

What can be cloned?



z/OS: It takes ~ 2.0-2.5 hours. Cloned by running ~50 batch jobs.

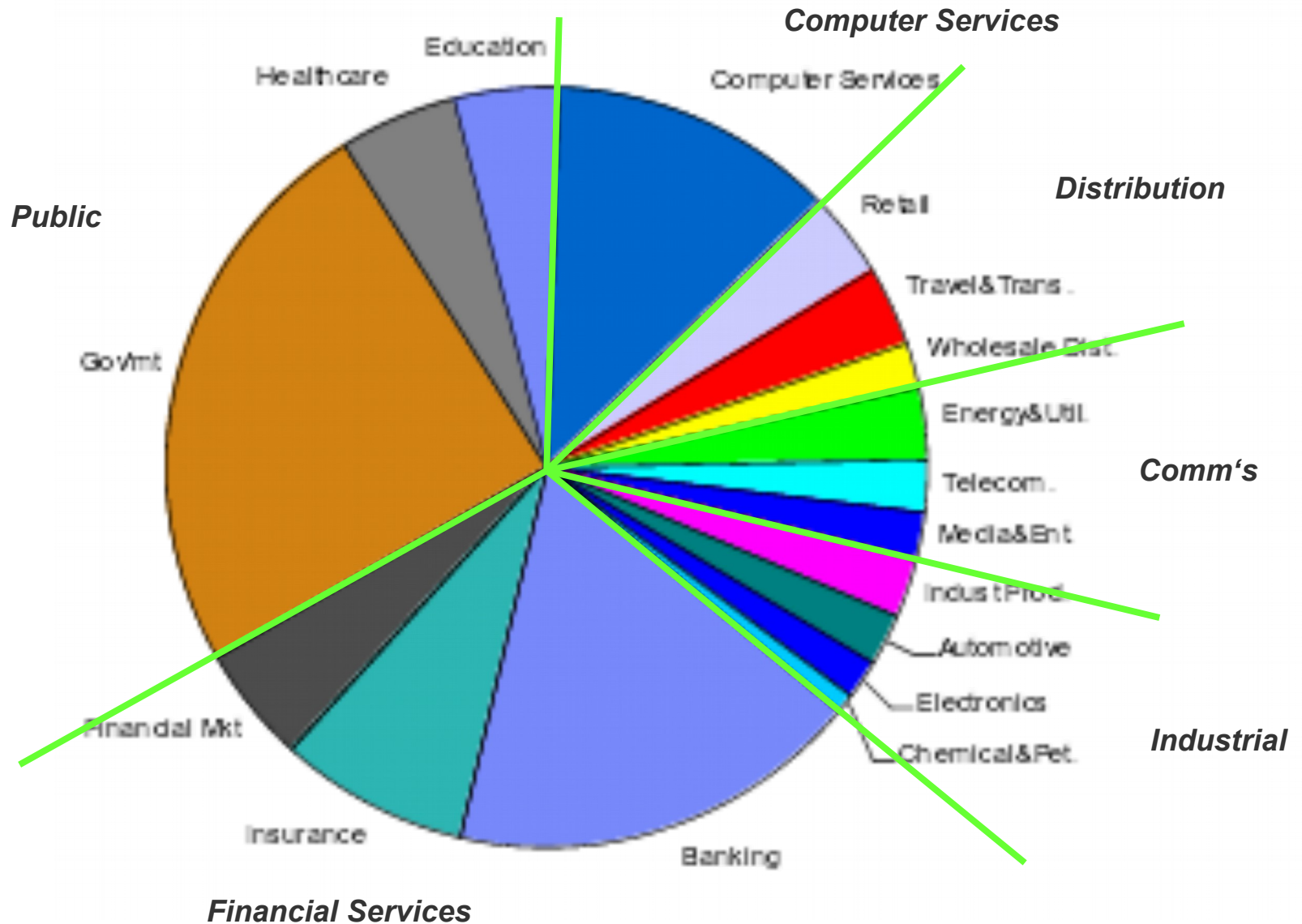


z/VM: Takes about 2-3 minutes to clone z/VM. But it takes 20-30 minutes if Flash Copy is not available.



z/Linux: Virtual Servers are cloned in < 5 minutes. ~15 minutes if Flash Copy DASD feature isn't available

Linux on System z Installations by Industry (1Q2012)



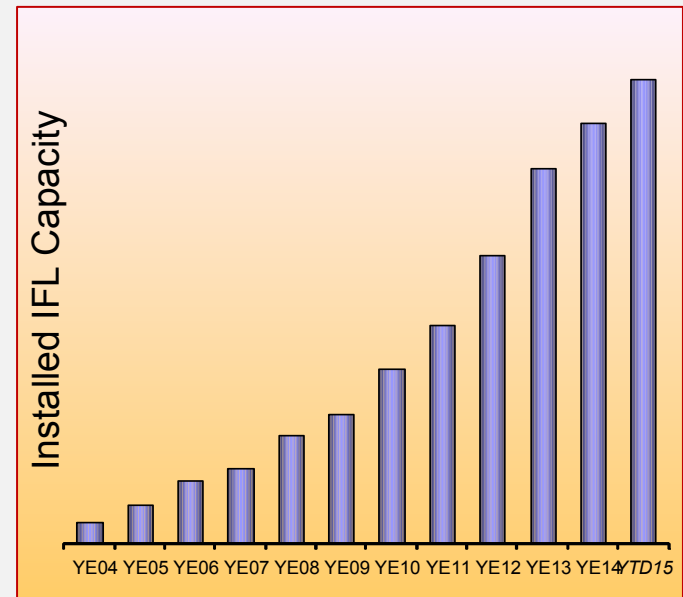
Linux on IBM z Systems in Q2 2015

Installed Linux MIPS at 45% CAGR*

- 26.7% of Total installed MIPS run Linux as of 2Q15
- Installed IFL MIPS increased by 16% YTY from 2Q14 to 2Q15
- 39% of System z Customers have IFL's installed as of 2Q15
- 79 of the top 100 System z Customers are running Linux on the mainframe as of 2Q15 **
- 35% of all z Systems servers have IFLs

§ 67% of new FIE/FIC z Systems accounts run Linux

Installed Capacity Over Time



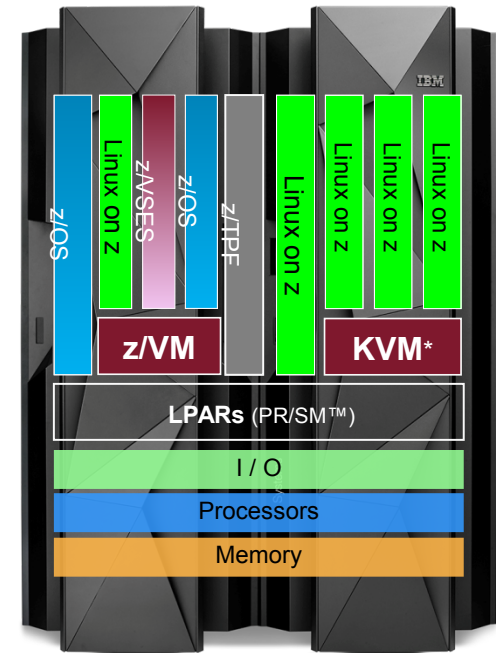
* Based on YE 2003 to YE 2014 **Top 100 is based on total installed MIPS

KVM for IBM z Systems

In addition to its continued investment in z/VM®, IBM intends to support a Kernel-based Virtual Machine (KVM) offering for IBM z Systems™ that will host Linux® on z Systems guest virtual machines.

- The KVM offering will be software that can be installed on z Systems processors.
- The KVM offering can co-exist with z/VM virtualization environments, z/OS®, Linux on z Systems, z/VSE® and z/TPF.
- The KVM offering will be optimized for z Systems architecture and will provide standard Linux and KVM interfaces for operational control of the environment, as well as supporting OpenStack® interfaces for virtualization management.
- Enterprises will be enabled to easily integrate Linux servers into their existing infrastructure and cloud offerings.

* All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.



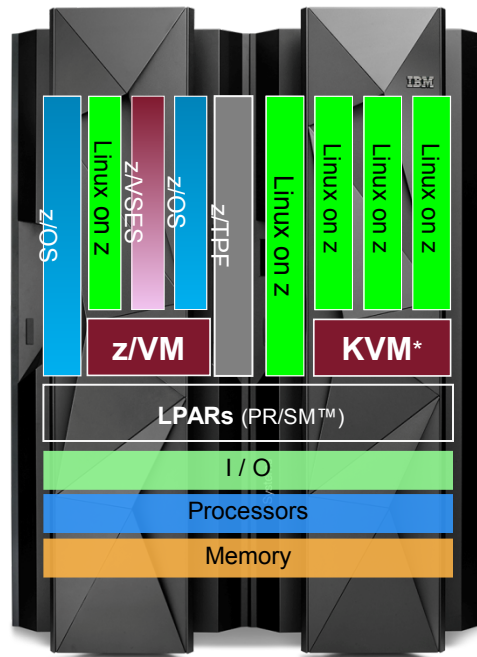
KVM for IBM z Systems and IBM z/VM can coexist

z/VM is IBM's virtualization

- World class quality, security, reliability - powerful and versatile
- Extreme scalability creates cost savings opportunities
- Exploitation of advanced technologies, such as:
 - Shared memory (Linux kernel, executables, communications)
- Highly granular control over resource pool
- Valuable tool for resiliency and Disaster Recovery
- Provides virtualization for all z Systems operating systems

KVM *

- Simplifies configuration and operation of server virtualization
- Leverage common Linux administration skills to administer virtualization
- Flexibility and agility leveraging the Open Source community
- Provides an Open Source virtualization choice
- Easily integration into Cloud/OpenStack environments



* See SOD - All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.

Thank you – Questions ?

Obrigado

Portuguese

Merci

French

Thank You

English

Gracias

Spanish

Danke

German



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In-demand skills for an on demand world.

IBM



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Frank Heimes, frank.heimes@de.ibm.com

Links

<http://www-03.ibm.com/systems/z/os/linux/>

<http://www.ibm.com/developerworks/linux/linux390/>

<http://linuxvm.org/>

<http://www.redbooks.ibm.com/>

<http://www-03.ibm.com/systems/z/os/linux/resources/index.html>

<http://brainworkshop.sourceforge.net/>

<http://www-03.ibm.com/linux/matrix/>

<http://www.gnu.org/philosophy/categories.html>

<http://www-03.ibm.com/systems/z/os/linux/resources/testedplatforms.html?>

z/VM 6.2 Information Center:

<http://publib.boulder.ibm.com/infocenter/zvm/v6r2>

IBM TEC Switzerland:

<http://www-05.ibm.com/ch/ibmforum/tec.html>

Open Source for z/OS:

<http://www.redbooks.ibm.com/redbooks/SG245944.html>

<http://www.lbdsoftware.com/>

<http://www-03.ibm.com/systems/z/os/zos/features/unix/tools/>

